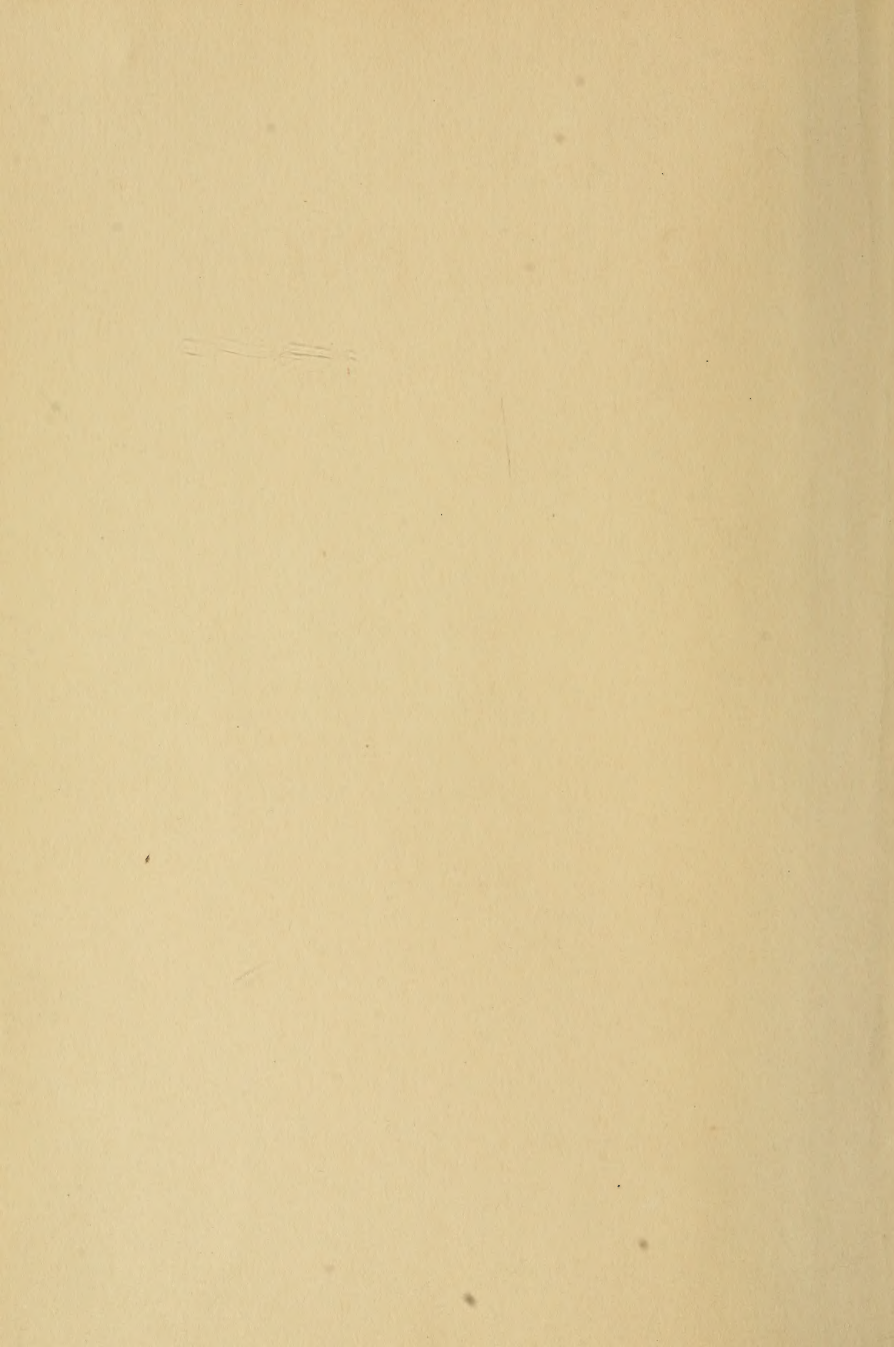


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FARM DAIRYING

A Treatise of Dairy Cattle, Their Feeding and Care
and the Handling and Disposition of Dairy
Produce on the Farm.

Christen
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ORANGE JUDD COMPANY

NEW YORK

1919

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DEC 29 1919

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To
Charles F. Curtis,
Dean and Director, Iowa State College
My Teacher, Advisor, Co-worker and Friend
This Book is Dedicated



PREFACE

IN THIS BOOK, treating of farm dairying, the author has endeavored to present the different phases of the subject in logical sequence. Much study has been given to dividing and systematizing the subject matter and to place the information in as good pedagogical form as possible.

These essentials of farm dairying are the results of many years of practical experience on dairy farms, results of study and observations made in the United States and in leading European dairy centers, results obtained from teaching and experimenting at the college with which the author has been connected, and results gathered from leading authorities in this country.

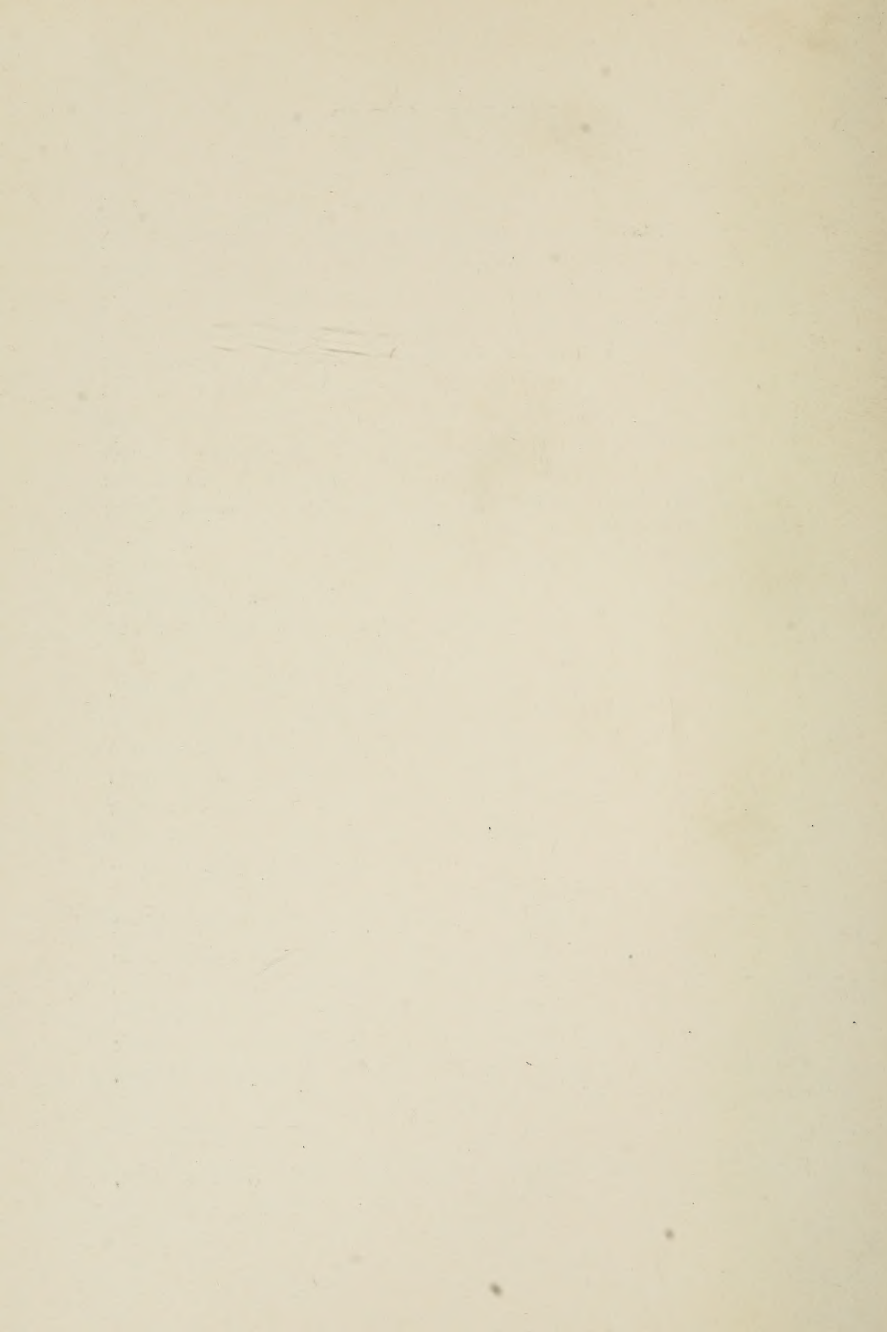
I cannot express too much appreciation to my co-workers for their help, and to the various college and experiment station authorities for having supplied the opportunities for securing this valuable information.

Though this book is published after the close of the war, it contains much information from pre-war conditions. The cost of feed and labor is much higher now than before the war. The present high scale of prices is not sure to continue, so the author believes that the pre-war data as to prices is more serviceable than if attempts were made to change so as to conform with present and maybe temporary high plane of prices.

The author has made it a point to discuss this subject of farm dairying in such a way as to make the book valuable to the practical dairy farmer, as a text for students, and as a convenient reference to anyone interested in the important subject of farm dairying. It is hoped the book will fill a need and give a real service in improving and encouraging the dairy industry.

C. LARSEN.

South Dakota State College of Agriculture and Mechanic Arts,
Brookings, South Dakota, July 12, 1919.



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CHAPTER I

CHIEF PURPOSES OF FARM DAIRYING

The purposes for which dairy farming is practiced vary according to the conditions and natural surroundings, to the degree of intensity, the extent to which it is followed, and the inclination and character of the dairyman. There are some who are engaged in dairy farming without having any special purpose in view. It is invariably the aimless dairy farmer who has proven a partial failure.

When properly practiced, dairy farming is full of merits, and it is conducive to good economic results and to home building. In spite of many misconceptions, wrong practices, and consequently, only partial results, the dairy business has made good returns, and has been constantly increasing in extent and in popularity.

The following table gives some idea of the extent to which dairy farming is practiced in the United States:*

	No. of Dairy Cows	Value per Head	Aggregate Value
U. S. Census, 1910	20,625,000	\$35.29	\$ 727,802,000
U. S. Census, 1914	20,737,000	53.94	1,118,487,000

The annual value of the dairy products in the United States is about as follows:

Butter, 1,619,415,263 lbs. @ \$0.35-----	\$566,795,342
Cheese, 320,532,181 lbs. @ \$0.25-----	80,133,145
Condensed milk -----	11,888,792
Cream sold -----	4,547,536
Milk sold -----	217,512,586
Milk fed to calves-----	39,000,000
By-products -----	41,049,226
Twenty million calves-----	100,000,000

Total value of dairy cow products-----\$1,060,926,527

The chief purposes of dairy farming in the United States may be classified as follows:

*Bulletin No. 177, B. C. E., U. S. Dept. of Agriculture.

1. To utilize field crops economically and to transform them into the maximum of animal products to be used for human foods and for human comforts.

2. To utilize labor profitably, especially during the slack seasons.

3. To reduce marketing expenses of field crops by reducing their bulk and weight.

4. To earn a sure income and obtain quick returns.

5. To make economical use of rough and otherwise waste land.

6. To obtain profits from the cow's power of reproduction.

Utilizing field crops for human foods.—Too often the question of utilizing the field crops does not receive the consideration which it deserves. A fundamental aim of human efforts is to produce human foods and human comforts. Many of the field crops, especially the roughage, cannot be used directly for human foods nor for human comforts.

To produce and harvest crops is one phase of farming. To utilize and market these crops in the most economical manner is another. Both are important and inter-dependent. It is said that the American farmer produces more new wealth per capita than any other farmer. It is generally conceded that the American farmer does not market his field crops so economically as do farmers of other countries. It is estimated that the American farmer obtains on an average about fifty percent of what the consumers have to pay for the articles produced on the farm. According to the best data obtainable, the Danish farmer, who probably employs the most efficient system of marketing in the world, secures about ninety percent of what the consumers pay for the farm products. The Danish farmer markets practically all of his field crops through the dairy cow and through the hog and the chicken.

Some farmers market the bulk of their crops by hauling them directly to market; others by having the horse trans-

form them into horse flesh; others by having the sheep transform them into wool and mutton; others have the hog transform them into pork and lard. Some again prefer to have the steer change the field crops into beef, and others have the dairy cow convert them into milk and butter fat. Some practice a combination of all, emphasizing one or more of these methods.

Under the widely different conditions existing in different localities, each of the above-mentioned methods of marketing field crops has its advantages and its disadvantages. The Central West farmer prefers to practice a combination of these methods. However, the profits accruing may be increased by carefully studying various methods and problems.

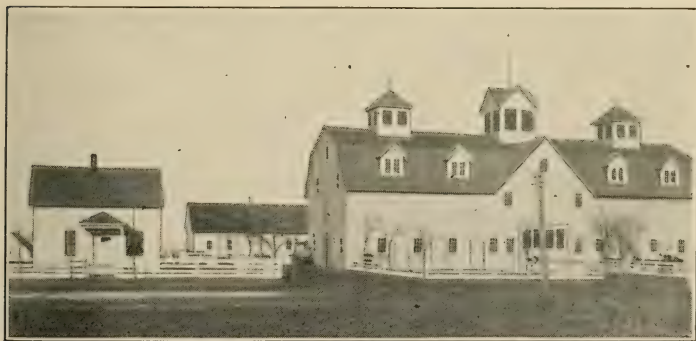


FIG. 1.—The herdsman's house and dairy barn at the South Dakota State College.

The right dairy cow, fed and cared for properly, will produce more healthful digestible human food from a given amount of field crops than will any other farm animal. This is a strong statement, but according to experimental results and demonstrations, it is amply substantiated. The following figures are given with the view of showing the comparative economy of the different farm animals as means of marketing the different field crops.

A reasonably good dairy cow, producing 40 pounds of four percent milk per day, will consume about 11 pounds of grain and 20 pounds of clover hay, or its equivalent in a mixed and properly balanced ration. The 40 pounds of milk contain the following amount of solids or dry matter, of which practically all is digestible.

$40 \times .04 = 1.6$ pounds of butter fat.

$40 \times .035 = 1.4$ pounds of protein (casein and albumen).

$40 \times .05 = 2.0$ pounds of milk sugar.

$40 \times .007 = 0.3$ pounds of ash.

5.3 pounds dry matter produced daily from above ration.

According to experiments, a little more than 96 percent of the milk proteins are digestible, and a trifle less than 96 percent of the carbohydrates of the milk sugar are digestible, and probably all of the butter fat is digestible. This means that 97 percent, or 5.14 pounds of dry matter of the daily milk produced by the dairy cow are digestible.

The ration fed to the cow contained about 9.9 pounds of dry matter in grain and about 18 pounds of dry matter in the hay. About 80 percent of the 9.9 pounds of dry matter in the grain, or 7.9 pounds, are digestible, and about 43 percent of the 18 pounds of dry matter in the clover hay, or 7.7 pounds, are digestible.

This dairy cow then consumes about 15.6 pounds of digestible dry matter, and recovers from it in the milk 5.14 pounds of digestible milk solids. That is, the dairy cow recovers about 33 percent of the digestible dry matter eaten, as digestible milk solids for human foods.

The hog, while not capable of recovering so large a percentage of the consumed feed solids for human food as is the dairy cow, ranks as one of the most economical animals. This is especially true when hogs are kept in connection with the dairy business. The by-products from the dairy, such as skim milk, buttermilk, and whey, when fed in connection with grain, according to various investigators, give the most economical gains. Henry of the Wisconsin station

found that on such a ration, properly proportioned, the hog gains one pound of live weight from three pounds of digestible dry matter.

According to Atwater, about 58 percent of the cured pork is digestible fat, and about 8.1 percent is digestible protein. There would then be about fifty-eight hundredths of a pound of fat and eight hundredths of a pound of protein, or a total of sixty-six hundredths of a pound of digestible dry



FIG. 2—The value of skim milk and buttermilk per 100 pounds for hog feeding is equal to five times the market price of hogs.

matter recovered by the hog from the three pounds of digestible dry matter consumed. This equals 22 percent.

The third common animal extensively used for transforming field crops into animal products is the steer. According to various investigators, a thousand-pound steer in the fattening lot consumes daily about 16 pounds of grain and eight pounds of hay, or its equivalent. About 90 percent of each of these feeds is dry matter, or 14.4 pounds in the grain and 7.2 pounds in the hay. About 80 percent

of the dry matter in the grain, or 11.52 pounds, is digestible matter, and about 43 percent of the dry matter in the hay, or 3.1 pounds. This makes a total of 14.6 pounds of digestible dry matter consumed daily by the steer having the above-mentioned weight. Results of several experiments show that if a thousand-pound steer gains two pounds of live weight per day, he is doing well. Atwater also found that about 14.5 percent of beef is digestible fat and about 16 percent is digestible protein. The above-mentioned gain contains three-tenths of a pound of digestible fat, and about thirty-two hundredths of a pound of digestible protein. This makes a total of sixty-two hundredths of a pound of digestible dry matter recovered by the steer from 14.6 pounds of digestible dry matter consumed. That is, he recovers about 4.2 percent for human food.

Then summarizing the comparative ability of each of these three common farm animals to recover human foods from the various field crops, we have the following:

The dairy cow recovers about 33 percent.

The hog recovers about 22 percent.

The steer recovers about 4.2 percent.

These results may range a little high for all of the above animals, as the data have been obtained from work performed at the different experiment stations. Under these conditions, the animals undoubtedly receive better care than is customary under average farm conditions. In addition, the animals used were perhaps of better quality than used under average farm conditions. However, great care has been taken to keep the data comparatively correct. From the above discussions, it will be noticed that there is a considerable waste of dry matter attended with having the field crops pass the roundabout way through the animal's body for human food. As population grows denser, the tendency will be to utilize as much of the concentrates, or grain, as can be used for human food directly, and to use the most profitable farm animals.

Roughages, such as corn fodder, hay, and straw, cannot directly be used as foods for people. To serve as such, they must be converted into animal products. Here the dairy cow excels. The hog, generally speaking, requires his food principally in the form of concentrates. The fattening steer needs a larger percentage of nutrients in the form of concentrates than does the dairy cow. Approximately speaking, the fattening steer eats two pounds of grain to one pound of hay, while the dairy cow reverses this ration to one pound of grain to two pounds of hay, or the equivalent in the form of other roughages.

The dairy cow has survived the most intensive farm conditions in the world. Years ago, very little was known about the chemistry of field crops and animal bodies, and therefore no calculations such as those made above could be made. Through actual practice and general observations, the farmers learned that the dairy cow was the most economical transformer of field crops. Where farms are small, land expensive, prices of feed high, and the population dense, as is the case in the best agricultural districts of Europe and the United States, there the dairy cow is used largely for the production of human foods and for human comforts, from field crops.

Utilizing labor profitably.—The responsibility of economically producing and marketing the world's food supply rests largely with the farmers. They stand at the source of all foods. They co-operate with the natural resources and with the elements to produce human food. Farm labor is an important item in producing the world's food supply.

In the temperate zone, especially in the central and central northwest United States, the crop-growing seasons are long enough to produce only one field crop each year. Consequently, there are about six months each year which constitute the growing season, and about six months when no crops can be grown. To produce new wealth only during half of each year is not good farm economics. In the central northwest, labor is employed on the farm, especially

on those where live stock is not kept, at the rate of about one man in the winter and two in the summer—in some instances, three. This means that at least one able-bodied man on each farm each fall is turned from a field of production of new wealth into a field of non-production of new wealth.

By practicing dairy farming to a greater extent, much of this labor could be economically utilized during the slack seasons. Our farms could be made factories for the continuous production of new wealth. The crops could be



FIG. 3—A comfortable and convenient place for winter dairying.

produced during the summer; and during the winter, labor and the dairy cow could profitably transform these field crops into concentrated expensive food products without removing the fertility of the land.

The time of the year for the dairy work can be regulated. Not so with any of the field crops. The time of freshening of a cow is within reasonable control of the owner. For the average dairy farmer the fall-freshening cow is the most profitable. The winter affords the most favorable condi-

tions for the farmer to get the best and most work out of the dairy cow. The labor is cheaper and more profitable. The prices of dairy products are about a third higher. The cow gives more milk during the year, and the fall calves are easier to raise.

In addition, the dairy cow affords opportunities for the various members of the family to partake in the work on the farm. The work in the barn and the dairy is not heavy work. It is work which requires attention and intelligence—two important characteristics which we wish to stamp upon every young person's life. So the purpose of the dairy cow in this connection is not only to use labor in a profitable manner, but to aid and develop industrious, attentive young people of regular habits.

The dairy cow has repeatedly demonstrated her ability to make large returns for the labor exerted and for food consumed. The dairy industry, though practiced only as a side issue in many places, constitutes one of the principal resources for taking care of the constant increase in the rural population, and provides for this increase a profitable employment. By practicing the proper system of dairy farming, two men can obtain profitable employment on a farm where formerly, under a system of grain farming, one man did the work. Stating it in another way, by proper dairy farming, eighty acres can be made to yield as much profit as will a 160-acre farm under the old system of grain farming.

Obtaining sure and quick returns.—As a safe investment, the dairy cow excels. The risk of growing a herd of dairy cows is less than that involved in handling other kinds of live stock. While there are diseases, and especially contagious diseases, affecting dairy herds, the attentive dairyman keeps the herd and surroundings in such a condition as to prevent and check any great losses from such sources. The dairyman keeps in close touch with every individual cow of the herd. The cows are taken into the barn, fed and milked twice a day. If any one member of the herd

shows symptoms of sickness, such as lack of appetite, or a lessened flow of milk, she can be attended to at once. It is different with other classes of animals allowed to run, perhaps for months, without receiving frequent attention.

The food which the dairy cow receives is transformed into a separate product, removed from the cow twice every day. If anything should happen to the dairy cow, no accumulated lot of products representing several months of labor and feeding would be lost. Only the machinery is lost. With almost any other animal, the owner sustains a

loss of not only the machinery used for transforming the feed, but also the accrued products, from months and even years.

The products from the dairy cow can be realized upon at once. In fact, the cow products are of such a perishable nature that it is almost necessary to market them at once. This quick transformation of the feed by the dairy cow, and the



FIG. 4—Corn on unmanured ground; yield 7 tons per acre. These two fields of corn were grown on the same quarter section of land.

ready cash sales of the dairy products, reduce the risk of live stock farming to a minimum and supply the dairyman with cash.

The dairy cow may also be considered a safety in crop production. While it is not commendable to anticipate a crop failure, the wise farmer does not rely entirely upon the field crops for his income. Late spring, wet or dry seasons,

hailstorms, injurious insects, and early frost are likely to hinder the production of a mature field crop. The dairyman who, for instance, has a silo can utilize an immature corn crop and have splendid feed for a dairy herd, while otherwise it would be difficult, if not impossible, to realize on such a corn crop.

Utilizing rough lands.—In some states and in some communities there is much rough and partially waste land which cannot be tilled. Such land may be seeded to permanent tame pasture, and the maximum returns obtained by grazing a herd of good dairy cows upon it. This is especially true where the land is inclined to be low and woody.

Although extremely swampy land is frequently used for dairy cow pasture, the writer would not advocate such use. Such land may serve for sup-



FIG. 5.—Corn on manured ground; yield 14 tons per acre.

plying feed for young stock, but for cows giving milk low land pasture of this kind grows grass that is coarse and not very appetizing. The cows should not wade around in swampy pastures, as their udders and teats are likely to become dirty. In the spring, during the wet season, it may be even difficult for the dairy cow to find a dry place on

which to lie down. In such low land, mosquitoes and other insects are usually very troublesome, especially during the middle of the summer. Outside of extremely low, swampy ground, however, the dairy cow can economically utilize rough land that cannot well be farmed.

Retaining and increasing richness of land.—Among the various phases of agriculture, dairy farming stands unrivaled as the greatest upbuilder of the soil. This is evidenced in every dairy community.

The dairy farmer who transforms all of his feed into dairy products removes very little fertility from his farm. This is shown by the following table, compiled by Armsby:

Manurial Value of Farm Products

	Pounds per ton			Value per ton			
	Nitrogen	Phosphoric acid	Potash	Nitrogen	Phosphoric acid	Potash	Total
Meadow hay	20.42	8.20	26.40	3.47	.57	1.06	5.10
Clover hay....	40.16	11.20	36.60	6.83	.78	1.46	9.07
Potatoes.....	7.01	3.20	11.40	1.19	.22	.46	1.87
Wheat bran	49.15	54.60	28.60	8.35	3.82	1.14	13.31
Linseed meal	105.12	32.20	24.80	17.87	2.25	.99	21.11
Cotton-seed meal ...	135.65	56.20	29.20	23.06	3.93	1.17	28.16
Wheat.....	37.53	15.80	10.60	6.38	1.11	.42	7.91
Oats.....	36.42	12.40	8.80	6.21	.87	.35	7.43
Corn.....	33.06	11.80	7.40	5.62	.83	.30	6.75
Barley.....	39.65	15.40	9.00	6.74	1.08	.36	8.18
Milk.....	10.20	3.40	3.00	1.73	.24	.12	2.09
Cheese.....	90.60	23.00	5.00	15.40	1.61	.20	17.21
Butter*.....	2.50	.76	.28	.37	.08	.05	.50
Live cattle ..	53.20	37.20	3.40	9.04	2.60	.14	11.78
Cream*.....	7.52	2.34	3.06	1.13	.14	.14	1.41

*Calculated from South Dakota Station analyses.

The manurial value of \$1000 worth of farm products fluctuates with the market prices. For this reason, the price is given in the following table, and represents about the current price at the time of writing.

The manurial value of \$1000 worth of each of the farm products, calculated from the above table, is as follows:

Manurial value of \$1000 worth of clover hay @ \$9 per ton	1007
" " " " " cottonseed meal @ \$30 per ton	904
" " " " " wheat bran @ \$20 per ton	665
" " " " " meadow hay @ \$8 per ton	640
" " " " " linseed meal @ \$40 per ton	552
" " " " " oats @ \$20 per ton	371
" " " " " corn @ \$20 per ton	337
" " " " " barley @ \$25 per ton	327
" " " " " wheat @ \$25 per ton	316
" " " " " live cattle @ \$100 per ton	118
" " " " " potatoes @ \$20 per ton	93
" " " " " milk @ \$25 per ton	83
" " " " " cheese @ \$300 per ton	57
" " " " " cream @ \$150 per ton	9.4
" " " " " butter @ \$500 per ton	.7

According to Cornell station, the different farm animals per thousand pounds live weight produce the following amount of manure, daily, having the composition shown in the following table:

Amount and Composition of Manure

	Amount per day	Analysis				
		% water	Nitrogen	Phosphoric acid	Potash	Value per ton
Sheep.....	34.1	59.52	.768	.391	.591	3.30
Calves.....	67.8	77.73	.497	.172	.532	2.18
Hogs.....	83.6	74.13	.840	.390	.320	3.29
Cows.....	74.1	75.25	.426	.290	.440	2.02
Horses.....	48.8	48.69	.490	.260	.480	2.21

The cow, then, produces about 13.5 tons of manure per year, which is ordinarily worth about \$2 per ton, or \$27 (value of nitrogen at 15 cents; phosphoric acid, 6 cents; potash at 4½ cents per pound). The above amount includes sufficient litter to keep the cow reasonably clean. According to the Pennsylvania experiments, about 37 percent of the above-mentioned manure voided is liquid, and the remainder, or 63 percent, is dung.

The question of conserving the soil fertility cannot be too strongly emphasized. The richness of the soil is a natural

heritage. Those who own the land do not own its natural plant food supply. They are simply trustees, and it is their duty to retain and even increase the richness of the land.

The west and central west should profit by the mistakes made in some of the older states. In the eastern part of the United States, and in some parts of the south, artificial fertilizers are used extensively. About \$100,000,000 worth of artificial fertilizers is used annually in the United States.



FIG. 6—Hauling liquid manure from a concrete liquid manure cistern.
(Courtesy Portland Cement Co.)

Artificial fertilizers may serve as stimulants for a short time, but they are expensive, and unless used in large quantities, are not effective.

By practicing dairy farming, and by hauling manure on the land, the productivity of the soil can be retained, because so little plant food is removed from the farm.

The richness of the land can even be increased, and usually is. The dairyman commonly buys some concentrated feedstuffs, rich in protein, such as bran, linseed meal,

gluten feeds, cottonseed meal, and other mill and brewery by-products. These, in addition to the feeds raised on the farm, are fed to the cows, and the manure returned to the land. Considering also that the dairyman usually tills his soil well, and that plant food elements are constantly set free, dairy farming not only maintains, but increases the productiveness of the land.

This is evidenced in practically all of the dairy localities in the United States, at least all that the writer has visited.

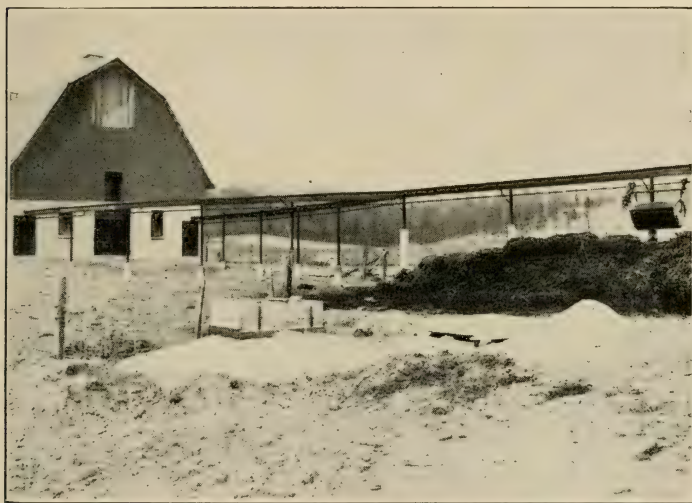


FIG. 7—Showing litter track and carrier. (Courtesy Portland Cement Co.)

The European countries practicing dairy farming intensively are prosperous, even in the face of high taxes, high rent, high prices of feed, and high value of land. Denmark was formerly a land of poverty. Since the dairy business gained a foothold, the masses are prosperous and well-to-do. Under the present system of dairy farming the yield from each acre has been doubled in about twenty years. The dairy industry in Denmark did not begin to develop until about 1883.

In the sections where the rainfall is low this question of retaining the soil fertility by dairy farming is of special importance. Dr. Widtsoe of the Utah station found that corn grown on well-manured land required 612 pounds of water to produce one pound of dry matter, while corn grown on unmanured land required 908 pounds of water to produce one pound of dry matter.

Reducing the marketing expense of field crops.—The average field crops, such as hay, straw, and grain, are bulky and heavy and expensive to market. Especially is this true for those who live in the central west and northwest states at long distances from central markets, and also for those whose farms are located a long distance from railroad stations. Many farmers are located from six to 15 miles

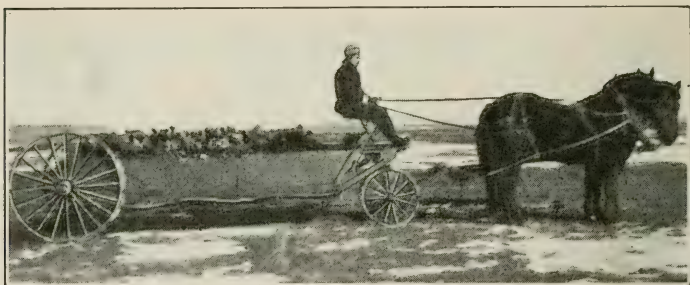


FIG. 8—Hauling the manure from the barn onto the field daily is probably the best method of handling manure on the dairy farm.

from a shipping point. Such farmers cannot load and unload and make more than one trip each day. To haul a load of hay or other feed to a railroad station will then cost the value of a day's wages, of team and man.

When this feed is loaded on the car at the local station, then there is the expense of transportation to the central market. From this territory to the Chicago market, the average cost of transportation per 100 pounds is about 20 cents, or about \$4 per ton.

During the winter months the dairy cow will eat about three tons of hay and one ton of grain. To get this feed

from the farm to the Chicago market will cost about as follows:

Hauling from farm to shipping point three loads of hay @ \$4---	\$12
Hauling from farm to shipping point one load of grain @ \$4----	4
Transportation or freight on four tons of feed from shipping point to central market @ \$4-----	16
Total cost of marketing feed for one cow every year-----	\$32

This cost has been calculated on the basis of carload rates, and does not consider elevator charges, nor commission for handling and selling at local and central market place.

One purpose of keeping the dairy cow is to reduce this marketing expense. A fairly good dairy cow should be able to change this feed into three hundred pounds of butter.

Cost of hauling 300 pounds of butter from farm to shipping point at 1 cent-----	\$3.00
Cost of transportation or freight on 300 pounds of butter to central market at 50 cents per 100 pounds-----	1.50
Total cost of marketing the butter-----	\$4.50

The other products from the cow, namely, the skim milk, the calf and the manure, remain on the farm.

A dairy cow thus reduces the cost of marketing field crops from \$32 to \$4.50, a difference of \$27.50. If the man maintains a herd of 15 cows, the total transportation expense saved annually is equal to \$412. This saving will, of course, vary somewhat according to localities. The above figures have been cited to illustrate the point that dairy cows will reduce the cost of marketing field crops.

This decrease in transportation charges is due chiefly to the fact that the dairy cow is especially well adapted to handling bulky field crops. The dairy cow can utilize a larger percent of the nutrients in the form of bulky and rough feeds than can any other farm animal. The three tons of hay and one ton of grain will occupy a space equal to about 1300 cubic feet. This much volume the cow will change

into about 300 pounds of the most concentrated human food known.

These figures cannot be accurate for all cases and for all conditions. However, they point with a great deal of significance to what the dairy cow is able to do in the way of changing bulky and weighty field crops into concentrated human foods for which there is always a ready demand at high prices.

One more factor should be considered in this connection. Some of the dairy products produced are consumed in the immediate locality, and do not need to be shipped at all. They are used as human foods in the immediate community where they are produced, while the field crops could not be thus utilized and therefore need to be transported to the big central markets if the farmer wishes to realize cash from them.

Reproduction.—The above discussion has been confined chiefly to the production only, to the turning of labor and feeds into dairy products and money. Another very important purpose for which dairy cows are kept is to reproduce. The better the cow and the better the sire, the more valuable is this phase of the cow's work. This work of reproduction is largely carried on at the same time that the cow performs the remainder of her functions. One case is on record where a calf sold for \$106,000. In several instances, one calf has sold for as high as \$10,000. This may be considered the maximum. The value of a cow's offspring may be said to vary from \$5 up.

The common value set on a calf does not justly measure the value of a cow for reproduction. A calf has a certain intrinsic market value, but in addition to this, an individual of a large producing strain and of a family of good type, is a carrier of valuable hereditary characteristics. The dairy cow is a vehicle for carrying the combined characteristics of her ancestors. This work of reproducing dairy qualities is one which many dairymen overlook. These qualities cannot be seen, cannot be handled, yet they form one of the

most valuable purposes for which we keep the dairy cow. This is especially true when the dairyman is trying to improve his herd.

The informed, wide-awake dairy farmer highly values this particular work of the dairy cow. As soon as farmers in general realize the importance of this the improvement of dairy cattle will go forward with astounding rapidity. At the present time, one owner of a dairy cow will concentrate this force of transmitting desirable characteristics, and another one working less intelligently will undo what has already been accomplished.

In some instances, cows are kept for the above chief purposes. In addition, many farmers value a cow for what she will bring after her dairy usefulness has ceased. Many farmers practice keeping large cows, and sell them before they are very old. Under such conditions, the value of the cow for the block is considerable. Probably such cows will net between \$30 and \$80 each.

CHAPTER II

THE DAIRY COW

The dairy cow is the foundation of the dairy industry. Without her, there would be no dairying. Upon the kind of a dairy cow, to a very large extent, depends the amount of profit obtained by the dairy farmer.

Strong statements have been made by breed enthusiasts relative to the merits and demerits of certain breeds. The writer's experience with all of the leading dairy breeds has taught him that it is not so much a question of what breed, as it is a question of individuality and of strain within a breed. There are many poor dairy cattle within any of the breeds. The person who obtains individuals in a family of large producers of Holstein cows will not want to part with them. On the other hand, if he obtains individuals that do not produce well, he naturally desires to make a change. It is similar with the Guernsey breed; it is similar with Ayrshires; and it is similar with Jerseys. The same thing holds true with cattle belonging to the other breeds.

Desirable form of a good dairy cow.—There can be no question that there is a relation existing between the form of an animal and its functions. The chief work of the dairy cow is to change field crops into dairy products and a calf. This particular work the dairy cow has been performing for many generations and for many hundred years. As a result, the cow has acquired a form that closely relates to her functions. This particular form has become hereditary. It has been thoroughly demonstrated that the ability to produce milk and butter fat by a cow is an hereditary characteristic, and that the form accompanying large production is also hereditary.

This principle may be illustrated in the human family, for instance, with a blacksmith. His right arm is more heavily

muscled and stronger than is the right arm of a person doing other forms of work. If this man's son is also a blacksmith, his right arm will be more heavily muscled and stronger, and so on down the line of the descendants. Eventually, it will not be necessary for these descendants to be blacksmiths in order to have strong right arms. It becomes an acquired hereditary characteristic. It is similar with dairy cows. They have been changing feeds into dairy products for so many generations, that the form that relates to milk production has become an acquired hereditary characteristic. It is this hereditary form which indicates large milk production and which we look for in picking a good dairy cow. At the present time this study of relation of form to function is by no means complete.

The important points to be considered in judging a dairy cow may be classified under four main heads:

1. Is she capable of consuming and digesting large quantities of feed, especially rough feeds, that is, has she a capacious and efficient digestive system?
2. Is she capable of converting these feeds into milk and butter fat economically, that is, has she capacious and efficient mammary organs, and the right dairy temperament?
3. Is she capable of doing this work for a long time and retaining good health, that is, has she a strong constitution?
4. Has she proper shape and symmetry? Under this heading is included breed, type, size, color, etc.

Ability to Consume and Digest Feeds

A cow's middle piece, or barrel, should have plenty of capacity for handling and digesting large quantities of rough feed. The barrel should be long, that is, the length from the hips to the shoulders should be great. It should also be deep, and wide. This does not mean that it should be wide near the top line. On the contrary, the cow's top line should be narrow. The ribs should gradually spread from the backbone in such a way as to give depth and width of body. A cow having large barrel capacity will

have ribs that are wide and placed far apart. The length, depth, and width of the barrel should be of such proportions as to make that part of the cow's body appear symmetrical.

In this connection it is well to examine the muzzle or mouth of the cow. A peaked mouth does not indicate good feeding quality in a cow. The muzzle should be wide and of good size. This one point is probably of little importance by itself, but when considered with the other qualities indicating large, efficient digestive capacity, it is a good indication.



FIG. 9—A cow long and wide of barrel, but lacks depth of body. This cow shows excellent capacity in front quarters.

The loin of a cow should be wide and reasonably level. This adds strength to the back of the cow and indicates strong kidneys. A sloping and narrow loin gives a bad appearance to the cow.

Capacity is not the only important thing in connection with the digestive system of the cow. She should also be an efficient user of feeds. The cow that can utilize the largest percentage of the consumed feeds or nutrients, and put it into the pail, is the most profitable.

A cow having efficient digestion usually has a skin of

good quality. The outside skin is a continuation of the lining of the digestive tract. The lining of the digestive tract contains the glands that secrete the pancreatic, gastric, and salivary juices. If the lining of the digestive tract is of good quality, more, and a better quality of digestive fluids are secreted. In connection with judging the efficiency of digestion, the quality of skin is of great importance. It should be velvety, loose, mellow, and of medium thickness.

The covering of the skin should also be soft, short, and downy. Hairs that are coarse, long, and stiff are not indicative of efficient digestion.

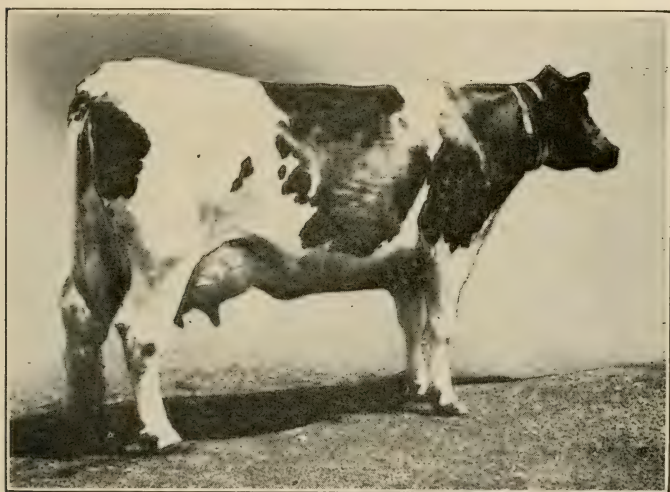


FIG. 10—A cow deep and wide of barrel, and showing good quality.

Most good dairy cows also have an oily skin. Sometimes the secretion is yellow. In some breeds of cattle, especially the Guernsey, this color of the secretion is of considerable importance. It is generally considered that there is a relation between the color of the skin secretion and the color of the milk. At any rate, a desirable skin should not be dry and scaly. The secretion should be copious and a yellow color is preferred.

Ability to Change Feeds Into Dairy Products

Large udder capacity.—Large udder capacity is probably the most important point in a dairy cow. The front udder should extend well forward under the abdomen. The hind udder should extend back and high up between two flat thighs. This will give the udder great length. The cow's udder should also be wide. This necessitates that the cow should be wide in the hind quarters and between the

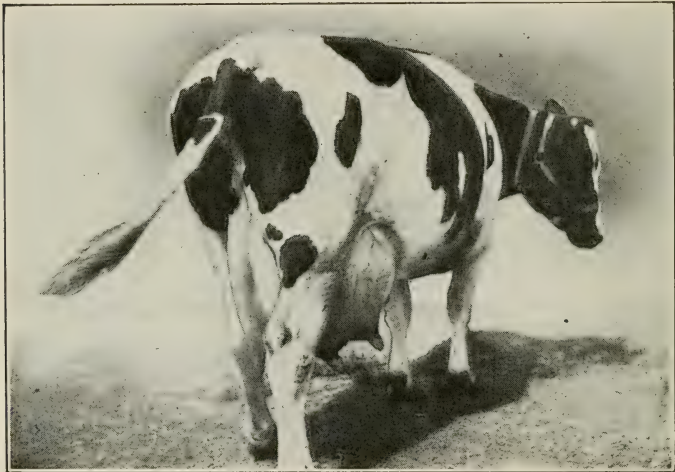


FIG. 11—College Belle Wayne 98497, bred and owned by South Dakota State College. This view was obtained when she produced 118 lbs. of milk per day. Weight 1975 lbs. Official records:

1 day, 126.7 lbs. of milk. 7 days, 824 lbs. of milk, 35.5 lbs. butter.
30 days, 3338 lbs of milk, 146.6 lbs. butter.

thighs. If a cow's udder is thus long and wide, there will be large udder area attaching to the cow's body.

The cow's udder should be of good quality. It must not be fleshy and hard when empty. Immediately after milking, the cow's udder should be soft, flabby and composed of quantities of loose mellow skin and tissue.

The cow's udder should also be of good shape. It should have a wide and level underline, and symmetrical and well-

placed teats of reasonably good size. The cow's udder should not be pendulous in shape. The udder should be held snugly up against the body of the cow. A low, pendulous udder is common to some old cows. This shape of udder does not necessarily indicate much ability to produce milk.

When a cow is not giving milk, it is more difficult to judge the udder capacity.

In this case, one may carefully examine the amount of loose skin enveloping the mammary gland and the shape of the hind quarters. The cow should have a long rump. The distance from the hips to the pin bones should be relatively great. There is a co-relation existing between the length of a cow's rump and the length of a cow's udder. Similarly, there is a co-relation existing between the width of



FIG. 12—College Belle Wayne, when not in milk.

a cow's hind quarter and the width of a cow's udder.

There is also a relation existing between the shape of a cow's hind quarter and the shape of her udder. If a cow is drooping behind, and the pin bones and tail setting are much lower than the hips, then the hind quarters of the cow's udder are much lower than the front quarters, and usually such a cow lacks in front udder development. The rump should not be depressed between hips and pin bones. The hind quarters of a dairy cow should be level, wide and long.

Blood circulation.—The blood circulation of the dairy cow is an important matter to consider. It is not sufficient that the general blood circulation of the cow is good, but a large percentage of the blood must be directed towards the cow's udder. The blood carries the raw material from which the milk is manufactured. The mammary gland, located in the cow's udder, is the organ which constitutes the machinery that makes the milk. Unless there is a large

supply of blood at the seat of milk manufacture, there can be no abundance of raw material from which the milk can be manufactured.



FIG. 13—A cow having a narrow, rough and droopy rump.

The mammary veins, or milk veins, as they are often called, should be large. These milk veins are located on the under part of the cow's abdomen, lying from the udder to the heart. They should be branching, especially near the udder. Most large producing cows have crooked or tortuous milk veins. Likewise, they have long veins. Hence, when selecting a dairy cow, a person should look for

long milk veins extending well towards the foreflank before they penetrate the abdominal wall, and for veins that are large, crooked, and branching.

In this connection, one should remember that the size varies with age. A young cow does not have as large milk veins as an older cow. They will also vary according to

whether a cow is in milk or not. During the first portion of the lactation period, the milk veins are larger than towards the latter part, or when the cow is dry, or almost dry.

At the end of the milk veins, or where they appear to end, towards the anterior part of the cow's body, there are openings through the abdominal wall. These are the openings through which the veins pass on their way towards the heart. These openings are called the milk wells. These milk wells should be large and they should be numerous. On a good dairy cow, there is usually one large milk well, and several small ones on each side. Where there are several small milk wells in connection with the large ones, the milk vein has a corresponding number of extensions. It can readily be seen that milk wells which are small and few in number do not permit a large flow of blood through them, even though the veins are large. Therefore, large milk veins do not mean so much as when both veins and milk wells are large.



FIG. 14—A cow having a wide, level rump.

Experiments conducted at the Oregon station show that these exterior veins are not the only passages of the blood. These veins were tied or completely shut off, yet the cow continued to produce milk in almost normal quantity. Some

cows may have the important veins on the inside of the body rather than where they may be seen.

The milk mirror, or escutcheon, has also been associated with the blood circulation of a cow. By milk mirror is meant the lay of the hair on the inner side of the thighs of the cow. A ridge of hair extends from the upper hind part of the cow's thighs down well towards the hock, at which place it usually ends in a twirl. This ridge results from the lay of hair coming from the twist on the inner side of the thigh meeting the lay of the hair from the outside of the

thigh. Most good dairy cows have a wide, long, and well-defined milk mirror.

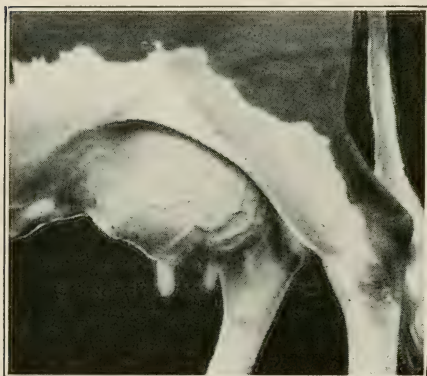


FIG. 15—Showing good shape and quality of udder, and also excellent mammary vein development. (Courtesy U. S. Dairy Division.)

Just what relation exists between milk production and the milk mirror is not known definitely. Some claim that it is an indication of the extra amount of blood that is supplied to the hind quarters of the cow. Most cows

give more milk from the hind quarters than they do from the front quarters. Such cows usually have a good milk mirror or escutcheon. There are some good judges of dairy cows who refuse to recognize any definite relation existing between the milk mirror and the production of the cow. It is true that there are many good producing cows that do not show much milk mirror.

This supposed relation of milk mirror to production was investigated and advocated by a Frenchman whose name was Guennon. His supposed discovery was carefully in-

vestigated by the French government, and the committee having this in charge reported favorably. It is also stated that a committee of experts representing the state of Pennsylvania investigated this problem and also reported favorably.

The writer can remember the time when it was difficult for a bull to receive a premium at the big dairy cattle shows in Denmark unless he had a prominent and well-defined escutcheon. There was less importance attached to the escutcheon of cows, but a dairy bull heading a herd and regarded of high standard should possess a good milk mirror. In connection with the other favorable qualities indicating large production, a wide, well-defined escutcheon is desirable.

Poise or carriage.—A cow that has good poise and carriage shows a healthful, bright, and lean appearance, when in milk and on good feed. Such a cow has large, bright, and prominent eyes. She has a refined feminine appearance. Such a cow has ears of good quality—ears that are well carried and even active.

A cow with good poise has a wide forehead, not too wide in the poll. She is not coarse and heavy in the throat-latch and the jaw bone. She has a prominent open-jointed backbone that carries out straight at the tail setting.

The forehead and backbone contain the brain and spinal cord respectively. These are the two chief parts of the nervous system. The wide forehead, with the other qualities mentioned above, indicates good brain capacity, and similarly a prominent backbone indicates a large spinal cord. Between each of the vertebræ the nerves radiate out to the various parts of the body. If the spinal column has an open-jointed appearance and the cow has good control over all of her movements, it indicates a free and certain flow of nervous energy to the various parts of the cow's body.

There are some who think that a good dairy cow is very nervous, ready to suffer a nervous collapse at any slight

excitement. This is contrary to the writer's experience. The largest and best producing cows with which the writer has come in contact are the cows which show the least nervousness. They are cows that seem to understand the surroundings. They do not become excited over every little unusual thing that happens.

Ability to Maintain Life and Health

To continuously change feeds into dairy products and to raise a calf each year is hard work for a cow. In order to stand this year after year, a cow must have a strong constitution.

The strength of the constitution is judged chiefly from the capacity of her front quarter. The thorax, or front quarter, contains two of the most vital organs of the cow, namely, the lungs and the heart. The lungs purify the blood, and the heart pumps it to the different parts of the body. Unless the cow has a large pair of lungs, and a strong, capacious heart, the work of digestion and milk secretion cannot be economically done.

The dairy cow should have a deep chest. The chest should also have good width. This applies especially to the lower part of the front quarter. A cow that is very narrow, having the two front legs extend from the chest very close together, usually has not a very large chest capacity. A cow should also have a shoulder that is oblique. The shoulder that is straight up and down does not give much length to the front quarters, while if the shoulder slants back, the cow usually has good chest capacity, lengthwise.

In addition, a cow should have a full and large heart girth. Many cows are notably weak in this place. Some cows are very depressed in the crops, or back of the shoulder near the top line. Some cows are also very depressed in the fore flank, or back of the fore leg near the underline. A contracted heart girth and a contracted chest are indications of a weak constitution.

A cow having large lung and heart capacity usually has a prominent windpipe, or trachea, and large nostrils. The nostrils and the windpipe serve as inlets for the fresh air. Unless these are large, the cow cannot take in large volumes of fresh air, nor expel large volumes of impure air from the lungs. These latter points should not be overlooked in judging a cow.

A cow having a strong constitution usually has a large, prominent navel. The size of the navel is considered an indication of the manner in which the individual was fed during the prenatal period. The navel is the place where the umbilical cord was attached before the individual was born. To what extent the size of the navel and the umbilical cord are indications of how the individual was nourished before birth is a question, but considering the fact that most good dairy cows have a large navel, it is deemed of some importance.

The general appearance of the cow should also be considered. A dairy cow which has small, depressed, elongated eyes, and drooping ears, and a general sluggish expression is not as a rule a cow with a strong constitution.

General Form

There is an old saying that "a chain is no stronger than its weakest link." This applies to a dairy cow. There is no cow any stronger than her weakest part. We, therefore, should look for symmetry of form. A symmetrical form is also attractive and beautiful. There is no reason why beauty cannot be combined with utility.

The various breed characteristics, such as size, color, etc., should be studied under this head.

The judging of dairy cows cannot be said to have been entirely standardized. Gov. Hoard once said: "The inside of a cow is a dark place." The study already made shows that the chief points referred to above are desirable and indicative of large milk production.

The extent to which such points as the kind of escutcheon

SOUTH DAKOTA STATE COLLEGE

Department of Dairy Husbandry

Students' Score Card—Dairy Cow

Name.....		SCORE		
SCORE OF POINTS		Female		
		Perfect Score	Student Score	Correct Score
I. ABILITY TO CONSUME AND DIGEST FEEDS (capacious and efficient digestive organs) 20 points				
Chiefly indicated by:				
1.	Deep, wide and medium long barrel, ribs broad and wide apart; broad, long, and not too sloping loins...	12		
2.	Large, wide mouth, not peaked.....	1		
3.	Loose, mellow, medium thick skin, yellow secretion, hair soft and fine.....	7		
II. ABILITY TO CHANGE FEEDS INTO DAIRY PRODUCTS (dairy temperament) 50 points				
Chiefly indicated by:				
1.	Udder capacity. 30 points			
(a)	Front udder extending well forward and under abdomen.....	7		
(b)	Hind udder extending back and high up between flat thighs.....	7		
(c)	Udder not fleshy.....	2		
(d)	Udder should be wide and level underneath and four symmetrically placed teats of good size...	4		
(e)	Thighs should be flat and wide apart, giving a roomy twist.....	2		
(f)	Cow should be level over hips, rump and pin-bones, and have a long, wide, rump.....	8		
2.	Blood circulation 10 points			
(a)	Large, branching, crooked and long mammary veins.....	6		
(b)	Large and numerous milk wells.....	3		
(c)	Long, wide spreading and well-defined es-cutcheon, or milk mirror.....	1		
3.	Poise 10 points			
(a)	Wide forehead, not too heavy and coarse in throat-latch, jaw bone and neck.....	2		
(b)	Lean, healthy, refined feminine appearance, bright and full eyes, well carried ears, and good body carriage.....	4		
(c)	Prominent, straight, open-jointed, backbone, reasonably straight at tail setting, and narrow at the withers.....	4		
III. ABILITY TO MAINTAIN LIFE AND HEALTH (constitution) 15 points				
Chiefly indicated by:				
1.	Deep and wide chest and spare shoulders.....	6		
2.	Large nostrils, prominent windpipe, giving large air inlet.....	2		
3.	Full and large heart girth, full in foreflank, full in crops and back of shoulders, giving large heart capacity.....	6		
4.	Large navel.....	1		
IV. GENERAL FORM and Breed Characteristics 15 points				
Chiefly indicated by:				
1.	Size.....	6		
2.	Color.....	2		
3.	Symmetry.....	7		
Total.....		100		

and crooked and long milk veins indicate large milk production is yet a question. Similarly, the extent to which the copiousness and color of secretion and skin, color of base of horns and hoofs, are indications of richness and color of milk, and whether or not richness can be judged, are yet questions.

The judging of cows should not be done entirely from a standpoint of milk production. Beauty of form may be combined with utility.

In Denmark, the following score card has been in use:*

Form and size.....	15 points
Quality and dairy temperament.....	12 "
Milking qualities	12 "
Pedigree	12 "
(Detailed information of ancestors.....	2)
(Premiums won by ancestors.....	3)
(Importance of family breeding.....	3)
(Detailed information as to milk and fat production	4)
Total	51 points

In Sweden, young bulls are judged by the use of the following score card:

Pedigree	3 points
Yield of ancestors.....	3 "
Form, general appearance, and strength.....	3 "
Total	9 points

The ability of a cow to produce milk and butter fat is hereditary. On this account, it would seem reasonable that a score card should give some weight to pedigree. In the judging of grade or unimproved cows, there would probably be a lack of information of ancestors, and therefore such a score card would be impracticable; but in the judging of pure-bred dairy cattle, it would seem practical and advisable to give room for this important feature. Each association of pure-bred dairy cattle now has a score card.

* Bulletin 129, U. S. Dept. of Agr. F. Rasmussen.

None of these, so far as known, includes this important feature. Yet, when a person starts out to buy a pure-bred animal of either sex, he puts a great deal of stress on the production and the type of the near ancestors. It would seem that this feature deserves a place on the breed score cards.

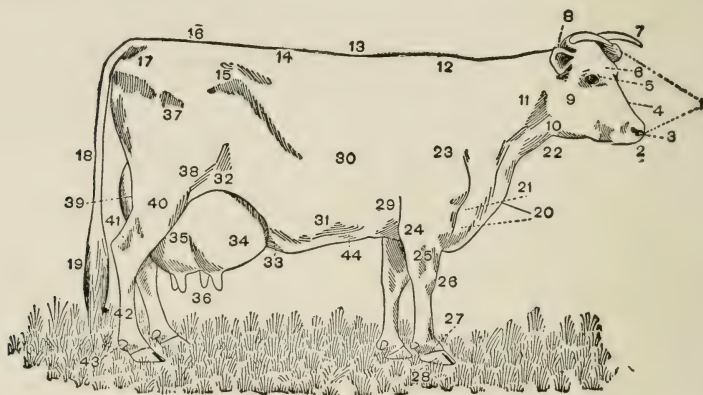


DIAGRAM OF COW SHOWING POINTS TO BE OBSERVED IN JUDGING DAIRY CATTLE (U. S. Farmers' Bull. No. 106) :

- | | | |
|---------------|---------------------|--------------------------|
| 1. Head. | 16. Pelvic arch. | 31. Belly. |
| 2. Muzzle. | 17. Rump. | 32. Flank. |
| 3. Nostril. | 18. Tail. | 33. Milk or mammary vein |
| 4. Face. | 19. Switch. | 34. Fore udder. |
| 5. Eye. | 20. Chest. | 35. Hind udder. |
| 6. Forehead. | 21. Brisket. | 36. Teats. |
| 7. Horn. | 22. Dewlap. | 37. Upper thigh. |
| 8. Ear. | 23. Shou'lder. | 38. Stifle. |
| 9. Cheek. | 24. Elbow. | 39. Twist. |
| 10. Throat. | 25. Forearm. | 40. Leg or gaskin. |
| 11. Neck. | 26. Knee. | 41. Hock. |
| 12. Withers. | 27. Ankle. | 42. Shank. |
| 13. Back. | 28. Hoof. | 43. Dew claw. |
| 14. Loins. | 29. Heart girth. | 44. Milk well. |
| 15. Hip bone. | 30. Side or barrel. | |

CHAPTER III

BREEDS OF DAIRY CATTLE

Development of breeds.—The different stages from the origin to the present development of our various breeds are not well known, but in a general way they are. The dairy cow is supposed to have descended from the native wild cow of Europe (boss primeval). Nothing definitely is known as to which species of the wild cattle our present domesticated breeds are derived from.

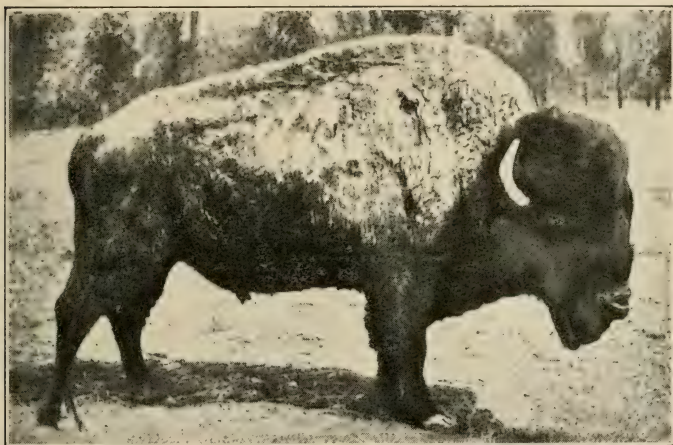


FIG. 16—The beef from the buffalo supplied food, and the hide was used for comfort and protection by the Indians and early settlers.

By reason of environment, these native cows were divided into two groups. Some of these lived in the mountains or highlands, where feed was scarce and the atmosphere rare. Under these natural surroundings, it was necessary for them to traverse considerable rough land and “rustle” for their feed. Individuals exposed to such environment for

many generations develop certain characteristics. They became active, well-muscled, and rather small of build. These qualities in time became acquired inherited characteristics.

The cattle that went into the lowlands developed differently, and acquired different inherited characteristics. It was not necessary for these cattle to "rustle" for their feed, nor to climb hills and mountains. Feed was plentiful. As a result, the native cattle in the lowlands developed greater



FIG. 17—The Longhorn was an important beef producing animal in the early days of cattle ranging. (Courtesy of Prof. J. M. Ridgeway, Texas Ag. College.)

size, more sluggishness, and less of the active characteristics.

Later on, the efforts of nature were supplanted by the efforts of man. The laws governing proper breeding and selection were not well understood, but it did not take long for observant persons to discover the general principle that "like begets like," and also that feeding had an important effect on shaping the form and functions of cows.

The breeding of cattle for special purposes has continued.

It was not sufficient to obtain one breed of dairy cattle and one breed of beef cattle, but there are now specialized breeds within each of these classes. For instance, there are breeds that are recognized as large milk producers, and breeds that are recognized as producers of very rich milk.

We thus recognize several stages in the development of the highly specialized dairy cow of today.

1. The effects due principally to natural surroundings and conditions.

2. The formation of classes of cows that were large milk producers, and classes of cows that were selected for beef, neither of which were yet very good dairy nor very good beef animals.

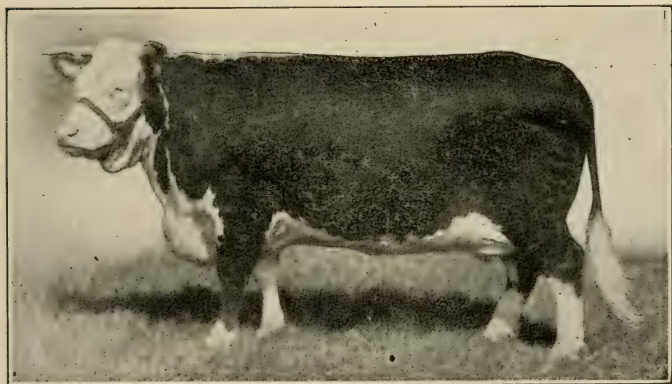


FIG. 18—The Whiteface or Hereford represents the improved type of range cattle and in good demand for beef production. (Courtesy of Dakota Farmer.)

3. The development of our special purpose beef breeds and special purpose dairy breeds.

4. The further tendency toward specialization within breeds. The foundations of our present leading breeds of cattle in the United States have all been imported from Europe.

Breeds of Dairy Cattle

As the principles of breeding and selection and their effects upon shaping the productive tendencies of cows became better understood, breeds of cattle for various purposes became numerous.

In the past, all of our different breeds of cattle have been classified into three groups:

1. Special purpose dairy breeds.
 - (a) Ayrshire
 - (b) Guernsey
 - (c) Jersey
 - (d) Holstein
 - (e) Brown Swiss
 - (f) Dutch Belted
2. Dual purpose.
 - (a) Milking Red Polls
 - (b) Milking Shorthorns
3. Special purpose beef cattle.
 - (a) Shorthorn
 - (b) Hereford
 - (c) Polled Angus
 - (d) Galloway
 - (e) Polled Durham

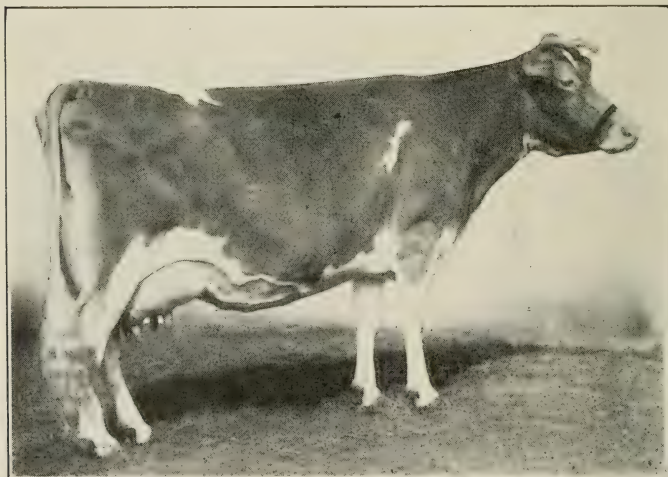


FIG. 19—Showing Princess Bergere 33074. She was Grand Champion Guernsey cow at the 1917 National Dairy Show. Official test in 300 days 516 lbs. of fat. (Courtesy W. W. Marsh, Waterloo, Ia.)

This classification has not been entirely satisfactory. There has been a tendency for several of the breeds to enlist in the dual-purpose class.

Some of the breeders of beef cattle have found individuals that have been fair milk producers, and have advertised them as dual-purpose. There have also been some dairy cattle breeders who have found considerable beef value in their young stock and have listed their breed as dual-purpose.

The general farmer in the central northwest naturally thinks that if he can get the best milking qualities and also the best beef qualities combined in the same animal, that that is the breed to which he should tie.

What is a dual-purpose or two-purpose cow? The two purposes for which the cow is kept are first, to produce milk economically, and secondly, to produce a calf that will feed with profit. This definition for a dual-purpose cow is very general. If there was a true standard definition for a dual-purpose cow there would not be so much discussion and even disputes on this particular point.

If a certain cow produces a calf that will net a profit of \$15 at the end of the year, and also a profit of \$15 on the milk produced, such a cow would be a dual-purpose cow. If a cow nets \$25 on the milk during the year, and \$15 on the calf, such a cow is pre-eminently a dairy cow, and should not be called a dual-purpose cow. A cow that produces a greater profit from the milk than from the calf during the year is manifestly a dairy cow.

The purposes of every cow are to produce and to reproduce. The difference is only in the extent to which they can produce milk economically, or produce a calf that will feed economically. The question of whether a cow is a beef cow, dairy cow, or a dual-purpose cow, is, then, a question of degree. So long as this is so, there will always be discussions on this particular point.

The ideal dual-purpose cow is the one that nets the same amount of profit from the calf and the milk during the year. Manifestly, it is almost impossible to produce or breed such an animal. The cow may be said to be a factory in which human food is manufactured from field crops. Every factory has a main product and also by-products. Milk is the main product from the dairy cow. The calf and manure are the by-products.

It should be understood that these two functions of a cow are here considered from the standpoint of producing human food, not from the standpoint of producing breeding animals.

Probably the greatest trouble with the above-mentioned classification is that within one breed there are beef animals that are never being milked and some dairy strains that are milked regularly. Some breeders of the so-called dual-purpose cattle adhere to the beef type, and do not milk the cows. They foster the beef qualities in their breeding and selection. Yet these cattle are advertised as dual-purpose. This is clearly wrong. The average dairy farmer does not always understand. He usually thinks that if an animal is a pure-bred belonging to the particular dual-purpose breed that animal contains the beef and also the milk qualities. The following classification would be less misleading and complex:

DAIRY BREEDS

- | | |
|----------------|---------------------|
| 1. Ayrshire | 6. Dutch Belted |
| 2. Guernsey | 7. Dairy Shorthorns |
| 3. Jersey | 8. Dairy Red Polls |
| 4. Holstein | 9. Dairy Devons |
| 5. Brown Swiss | |

A good milking Shorthorn cow or a good milking Red Poll cow has a form similar to any other good milking cow. The difference is chiefly in the size and the color. The relation of form to function is very close.

BEEF BREEDS

- | | |
|-------------------|------------------|
| 1. Aberdeen-Angus | 5. Red Polls |
| 2. Galloway | 6. Polled Durham |
| 3. Hereford | 7. Devons |
| 4. Shorthorn | |

Ayrshire.—The Ayrshire breed comprises cows of medium size, giving a medium large quantity of milk and con-

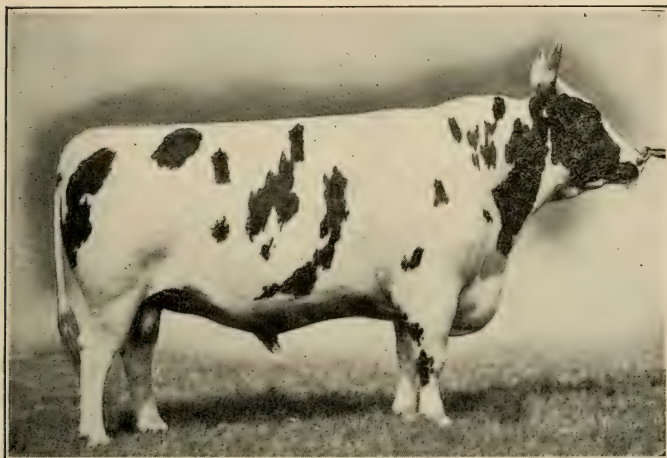


FIG. 20—Ayrshire bull, Imp. Howie's Mint Master 15819.

- | | | |
|--|---|--|
| Imp. Howie's Mint Master 15819
Senior Champion Ayrshire Bull
National Dairy Show 1917 | Carleton Steadfast 8806
First as a 2 yr. old
Castle Douglas | Duke of Argyll 7493
First and medal at Lesmagow
also at Hamilton. First at
Lanark, also at Peebles, and
first and gold medal as best
animal in Ayrshire section
at Biggar |
| | Hillhouse Cherry 10th 19951
9161 lbs. of 3.57% milk
in 46 weeks. Dam of
Hobsland Masterpiece.
1st and champion male
at Inverness Highland
show | Snowdrop of Hillhouse 12021
9131 lbs. milk of 3.7% fat in
38 weeks |
| | | Brown Prince 5059
First Lanark and West Linton
as yearling |
- Cherry 7th 14958**

taining a medium percent of butter fat. The average weight of an Ayrshire cow is about 1100 pounds, and the average milk production is about 7000 pounds of milk, testing about four percent of butter fat.

The color of the Ayrshire cow varies. Some are almost white. The prevailing color is red and white.

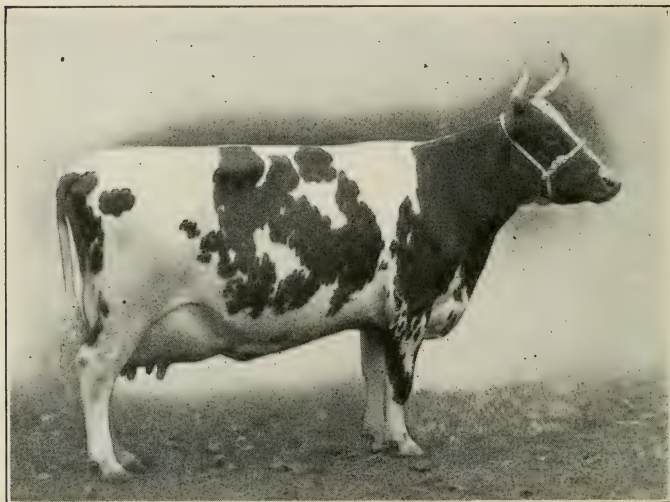


FIG. 21—Ayrshire cow, Shewalton's Mains Queen.

Shewalton's Mains Queen 37965 (A. R. 1830) M-Records: 12,853 lbs. milk, 512.30 lbs. fat 10,197 lbs. milk, 411.36 lbs. fat Great breeding and show cow. Grand champion female at Nat. Dairy Show 1917	Raithhill Look Up "11538" Shewalton's Mains Queen (A. R. 1830)	Raithhill General Hunter "5337"
	Slatehole Young Lessy "App. A., No. 1638"	Raithhill Jean's 1st "App. vol. 26, p. 454" Bargenoch Royal Kyle "5160" Brother to Blossom 3rd of Bar- genoch "13074." Scotch rec- ord at 13 yrs: 9200 lbs. milk in 26 weeks' testing 4.65% and the dam of Netherton King Arthur, one of the great breeding sires of Scotland. Slatehole Lessy "App. B. No. 2116"

As a rule, the Ayrshire cows have a deep, wide, wedge-shaped body. The udder is large, square, and symmetrical, almost ideal in shape. Sometimes the teats are short. This has been one of the principal objections raised to this breed.

Progressive breeders, however, are endeavoring to overcome this objection, and to a certain extent have succeeded.

The Ayrshire breed of cattle originated in the southwestern part of Scotland in the county of Ayr. This native home of this breed comprises areas of rough land. The climate is rigorous and more severe than are the native homes of the other three leading breeds of dairy cattle. Such conditions are conducive to the development of good "rustling" qualities. The Ayrshire breed ranks first among the dairy breeds as to ability to "rustle" for feed.

At the present writing, the champion Ayrshire cow is Lily of Willowmoor 22269, with a production of 22,596 pounds of milk containing 955.56 pounds of butter fat. She is owned by J. W. Clise of Washington.

The Ayrshire breed association has its central office at Brandon, Vermont, from which place additional information regarding this breed may be obtained.

Table Showing Number of Cattle Registered in the Different Breeds Used for Milk in the United States, to June 1, 1917.

Breed	Number registered		
	Males	Females	Total
Ayrshire.....			
Guernsey.....	42,280	70,910	113,190
Holstein.....	216,494	393,997	610,491
Jersey.....	153,230	385,133	538,363
Shorthorns*.....	497,000	738,000	1,235,000
Polled Durham*.....	15,330	19,952	35,282
Red Polls*.....	32,207	46,590	78,797
Brown Swiss.....	6,074	8,727	14,801
Polled Jersey.....	514	899	1,413
Dutch Belted.....	1,250	2,521	3,771
French Canadian.....	230	785	1,015
Dexter.....	42	210	252
Kerry.....	16	59	75

* Including beef and dairy.

Guernsey.—This breed of cattle originated on the island of Guernsey, one of the Channel island group, located off the coast of France, in the English Channel. This island is about seven by six miles, and has a population of about

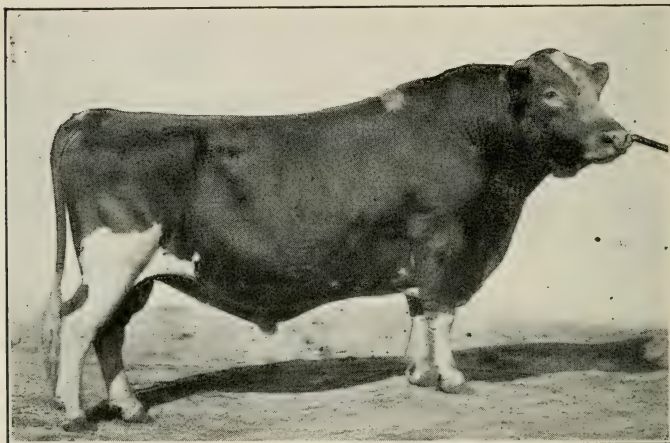
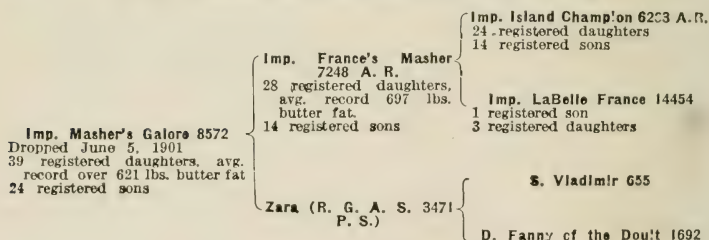


FIG. 22—Guernsey bull, Imp. Masher's Galore 8572 A. R.



thirty-five thousand inhabitants. Land on the island is very valuable, and farming is carried on very intensively. By reason of its location, the climate is uniform and mild.

Although Guernsey cows are not large, they are deep of body, and have remarkable ability to transform feed into dairy products economically. The average weight of the Guernsey cow is about 1000 pounds. On an average, the

Guernsey cow produces about six thousand pounds of milk testing about five percent of butter fat.

The products from this breed are very high in color. In this respect the Guernsey cow excels all other breeds.

The color of the Guernsey cows also varies. As a rule, it is fawn with white spots well distributed all over the body. Some, however, have almost a light red color.



FIG. 23—Guernsey cow, Langwater Dairymaid 26377.

Langwater Dairymaid 26377 (A. R. 1460) Record: 16,949.20 lbs. milk; 812.66 lbs. butter fat	{ Jethro Bass 11366 A. R. 29 registered daughters, 13 of which have avg. record of 687 lbs. but- ter fat Sons, 39 registered.	{ Imp. King of the May 9001 A. R. Daughters, 52 registered, 24 of which have avg. record of 693 lbs. butter fat Sons, 35 registered
		{ Dolly Bloom 12770 A. R. Record: 17,297.51 lbs. milk. 836.21 lbs. butter fat
	{ Imp. Itchen Da'sy III 15630 A. P. Record: 13,636.8 lbs. milk 714.1 lbs. butter fat	{ May Day 1132 E. G. H. B. Daisy's Cem 3341 E. G. H. B.

The present champion Guernsey cow is Murne Cowan No. 19597. She produced in one year 24,008 pounds of

milk containing 1098.18 pounds of butter fat. She is owned by Anna Dean Farm of Ohio.

Additional detailed information relative to this breed may be obtained from the American Guernsey Cattle Club, Peterboro, N. H.

Jersey breed.—The Jersey cattle came from the island of Jersey. Although this island is the largest of the Chan-

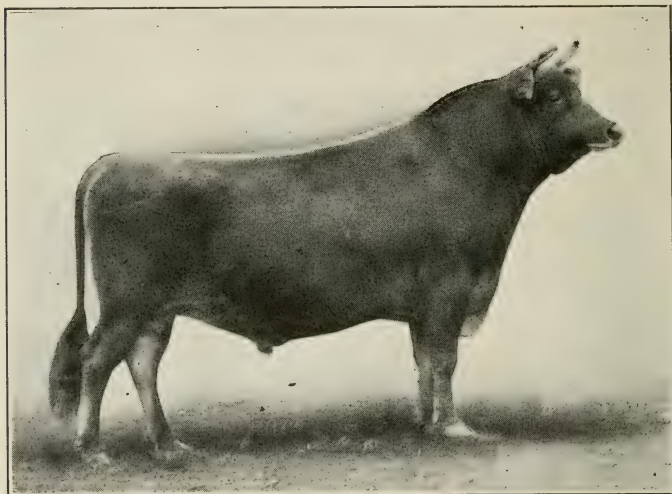
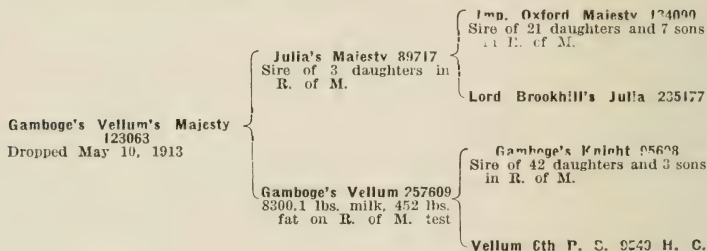


FIG. 24—Jersey bull, Gamboge's Vellum's Majesty 123063.



nel island group, it is only about eleven by six miles. It contains nearly sixty thousand inhabitants.

The climate, feed and surroundings on the island of Jersey are much similar to those of the Guernsey island, though the former is a little milder.

Although the natural conditions and surroundings of these two Channel island breeds have been similar, there are



FIG. 25—Jersey cow, Oxford Majesty's Gypsy 344076.

Oxford Majesty's Gypsy 344076 Dropped April 11, 1911; weight 950 lbs. Record: 9114.6 lbs. milk, 543.02 lbs. butter fat	{ Imp. Oxford Majesty 134090 Sire of 21 daughters and 7 sons in R. of M.	Royal Majesty 79313 Sire of 37 daughters and 5 sons in R. of M.
		Oxford Lad's Lucy 213913
	{ Imp. Gipsy Malden 345340	General Fox 2d P. S. 3309 H. C. On I. of J.

some differences in the two breeds. The Jerseys, as a rule, are solid of color, dark on the lower half of the body, and gradually growing into a fawn near the back line. A few of the Jersey cattle are broken in color, having white spots. The individuals of the Jersey breed, as a rule, have a black

or dark switch and tongue. The individuals of this breed are smaller than are the Guernseys. The average Jersey cow weighs about 950 pounds.

There are two well-defined types of the Jersey; namely, the American type, and the Island type. Those belonging to the former are much larger and coarser than are those belonging to the Island type. The Jersey cows belonging to the Island type are fine-boned, thin-skinned, and not so coarse as the American type.

The Jerseys, like their sister breed, give rich milk, averaging about five percent of butter fat. They produce on an average close to six thousand pounds of milk in a year. This particular breed has on various occasions demonstrated its ability to produce butter fat economically. This was especially shown at the St. Louis World's Exposition. In this test, the Jersey breed won over all other breeds.

The cattle on the Guernsey and Jersey islands are all pure-bred. Importation of other cattle has been prohibited for many years. There are, however, two classes, the pedigreed stock and the foundation stock. Because importations are forbidden and because of strict sanitary laws, the Channel island breeds are remarkably free from contagious diseases.

The present champion Jersey cow is Vive La France 319619. She produced 14,925 pounds of milk and 1013.64 pounds of butter fat. She is owned by O. Pickard, Marion, Oregon.

The main office of the American Jersey Cattle Club is at 324 West 23d Street, New York City, where further information regarding this breed may be obtained.

The Holstein-Friesian breed.—These cattle originated in the province of Friesland in the country of Holland. This part of Holland borders on the North Sea, and is low, fertile land. Together with the skill of the breeder and feeder, this natural environment has produced a breed of cattle the individuals of which are large, deep of body, and wide and open of form. The individuals of this breed are

the largest of any of the dairy breeds, and probably the largest of any breed.

The Holstein-Friesian breed of cattle is one of the oldest. It can be traced to about 400 B. C. This breed of cattle has been known in Holland for many centuries for the large

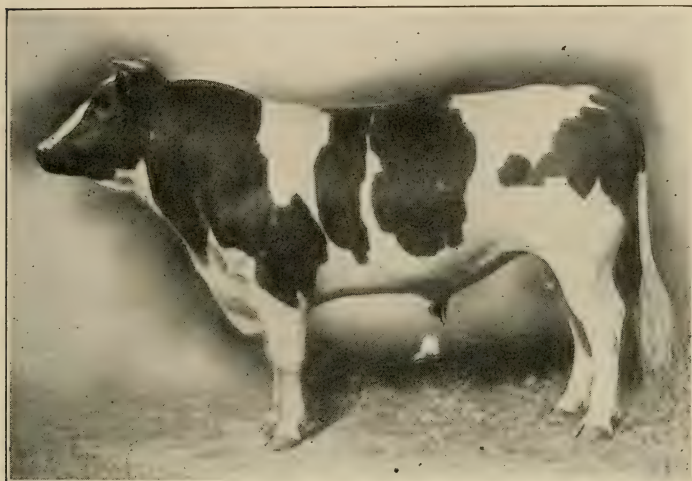


FIG. 26—Holstein bull, King of the Pontiacs 39037. Sire of 235 A. R. O. cows and 134 proven sons.

King of the Pontiacs 39037
Dropped March 5, 1905
Approx. weight 2500 lbs.
Sire of 235 ARO daughters, 135
sons with ARO daughters
K.P. Pontiac Lass 44.18
K.P. Diona Pietertje 40.15
K.P. Mercedes Prilly 34.25

Pontiac Korndyke 25982
145 ARO daughters
Pontiac Lady Korn-
dyke 38.03
Pontiac Pet 37.68
Pearl Neth. Korn-
dyke 37.52
Pont. Clothilde De
Kol 2d 37.21
Sadie Vale Korn-
dyke 36.20
101 sons with ARO
daughters

**Pontiac Lunde Henger-
veld 51585**
Record:
7 days, 559.80 lbs.
milk, 28.41 lbs. butter
30 days, 2405.20 lbs.
milk, 114.82 lbs. butter

Manor Josephine De Kol 22779
6 ARO daughters
Manor Star's Jose, 3½y. 20.90
Susie Josephine 3½y. 20.72
5 sons with ARO daughters

Belle Korndyke 13913
Record: 7 days, 509.80 lbs.
milk, 25.77 lbs. butter

Hengerveld De Kol 23102
116 ARO daughters, 10 with
record above 30 lbs., 68
with records from 20 to 29.87
66 sons with ARO daughters

Lunde Beauty 34745
Record: 7 days, as 2 yr. old,
280.90 lbs. milk, 11.84 lbs.
butter

amount of milk produced, and for the large oxen obtained from them.

The individuals of this breed have great capacity for utilizing large quantities of rough feed, and transforming it into large quantities of milk. The average annual production of a Holstein cow is about eight thousand five hundred

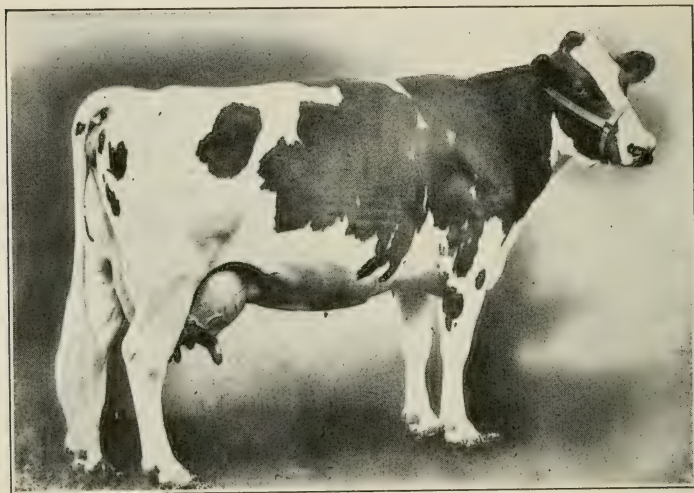


FIG. 27—Holstein cow, Duchess Skylark Ormsby 124514, world's champion cow. Year record 27,761.7 lbs. milk, 1506.36 lbs. butter.

Duchess Skylark Ormsby 124514 Dropped Oct. 31, 1909 Approx. weight 1800 lbs. Record: 27,761.70 lbs. milk 1506.36 lbs. butter World's record of Holsteins and over all breeds		Sir Ormsby Hennerveld De Kol 31212 69 ARO daughters 4 with records from 30 to 35.56 36 others from 20 to 29.28 lbs.	
		Sir Ormsby Skylark 47010 11 ARO daughters Duchess Skylark Ormsby 34.36 Buffalo Sen-Sen Skylark 26.71 Buffalo Parthenea Skylark 25.06 Buffalo Posch Skylark 23.72 Buffalo Banzie Skylark 21.87	
		Skylark Mercedes De Kol 52644 Record: 7 days 452.90 lbs. milk 22.67 lbs. butter	
		John of Barneveldt 35865 2 ARO daughters Oakhurst Duch. Cloth., 4½y. 19.87 Milk 494.90 Oakhurst Paladin, 2½y. 13.78	
		Clothilde Princess Oakhurst 85252 Record: 7 days 473.80 lbs. milk 16.86 lbs. butter	
		Oakhurst Duchess Clothilde 106988 Record: 352 days 15,764.60 lbs. milk 640.00 lbs. butter	

pounds of milk, testing about three and five-tenths percent of butter fat. The Holstein-Friesian cows give the largest flow of milk of any dairy cattle, but it contains a lower percent of butter fat than the milk from any of the other dairy breeds. The progressive breeders are now endeavoring to improve this, and judging from the records in the advanced registry, if this is a fair basis, the percent of fat is gradually increasing.

The Holstein-Friesian cattle are black and white in color. So far as known, there is no definite relation between color and production. The Holstein-Friesian breed of cattle has been reared singularly free from fads and styles.

The breeders of Holstein cattle have been foremost in the testing of cows for advanced registry. It was the first breed association to start official testing. The rules by which these tests are conducted are strict. The advanced registry records have enabled the Holstein-Friesian Association of America to show the productivity of the breed. Perhaps the greatest usefulness of these records is that they enable breeders to locate the best producers and families in the breed. In this manner, breeders have been better able to select good foundation stock. The observance of the principle of hereditary connection with production is well demonstrated in the Holstein-Friesian breed and also in the other leading dairy breeds.

The calves from this breed are large. They frequently weigh about one hundred pounds at time of birth. This makes the Holstein calves very desirable for veal purposes. The weight of a Holstein calf at time of birth exceeds that of any other breed.

The champion cow of the Holstein breed, which is also the world's champion cow at the present writing, is Duchess Skylark Ormsby, No. 124514, with a record of 27,761 pounds of milk containing 1205.09 pounds of fat. The average test is 4.34 percent. This cow is owned by John B. Irwin of Minnesota.

The head office of the Holstein-Friesian Association of

America is Brattleboro, Vermont, from which place additional information may be had.

Summary of four leading dairy breeds.—The dairy farmer should endeavor to select the breed which he likes the best. As a rule, a man does not succeed with anything he does not like.

Secondly, the kind of dairying and the market for the dairy produce have a bearing upon the breed to select. For instance, if rich and highly colored milk is desired, then Guernseys or Jerseys should be selected. If milk of large quantity and of less richness is desired, then the Holstein-Friesian breed is most desirable.

Thirdly, if the dairyman desires to keep registered stock, he should also be guided by the demand for young stock from the particular breed in his locality.

Fourthly, the kind of land owned by the dairyman and the kind of climate should have some bearing as to what breed to select. If the climate is rigorous, the farm composed of rough, low and half waste land, and the herd is expected to face such conditions, then probably the Ayrshires would be most suitable.

As to hardiness and the ability to handle rough feeds, the dairy breeds rank as follows: Ayrshire, Holstein, Guernsey, and Jersey. As to amount of milk, the different breeds rank as follows: Holstein, Ayrshire, Guernsey, Jersey. As to quality of milk, they rank as follows: Jersey, Guernsey, Ayrshire, and Holstein. As to color of milk, the Guernsey ranks first, then Jersey, Ayrshire, and Holstein. As to size, the Holstein breed ranks first, Ayrshire second, Guernsey third, and Jersey fourth. There are profitable and large producing individuals and strains in all of these breeds, and there are also poor ones in all of the breeds. It is of greatest importance to emphasize individuals or families within a breed. This is probably of greater importance than emphasizing breed. The fact that certain individuals belong to one of the above mentioned dairy breeds is no assurance that they are profitable performers. Im-

proper selection within a breed has often discouraged dairy-men with a certain breed of dairy cattle.

The less common dairy breeds.—Many dairy farmers of the central west have inherited a certain liking for the square, fat, and smooth cow. During the range period, and during the immediate succeeding period, this type of cow has been set up as an ideal. The lean type of dairy cow, with a wedge-shaped body, does not always appeal to the man who has been educated to the other type and has had experience with it.

For this reason, many dairy farmers in the central west select one of the breeds of cattle that has not been extremely developed for dairy purposes. They feel that as land increases in value and as farms become smaller and feed higher in price, they need to have more than a calf from the cow every year, hence they select one of the so-called dual-purpose types. They get as much milk as they can from these cows, and raise a calf on the skim milk. Those who practice this method, as a rule, make more money from the cows than do those who are not milking at all. This period apparently spans the range and the intensified farming period. As the population increases, as farms become smaller, and as land grows more expensive, less use is made of the general-purpose cow.

Table Showing Composition of Milk from the Different Breeds

Breed	Total solids Percent	Fat Percent	Proteins Percent	Milk- sugar Percent	Ash Percent
Ayrshire.....	12.88	3.62	3.45	5.03	0.7
Guernsey.....	14.54	5.07	3.76	4.95	0.75
Holstein.....	12.25	3.48	3.33	4.76	0.69
Jersey.....	14.87	5.19	3.94	5.00	0.75
Dairy Shorthorns.....	12.45	3.65	3.27	4.80	0.73
Devon.....	13.77	4.15	3.76	5.07	0.76
Red Polls.....	12.96	3.92	.....	.....	.....
Brown Swiss.....	13.27	4.24	.....	.....	.....
Dutch Belted.....	12.40	3.6	.....	.....	.....
Kerry.....	13.70	4.7	.....	.....	.....
Dexters.....	13.37	4.18	.....	.....	.....

The **Brown Swiss** breed of cattle came from Switzerland. This breed is famous as a producer of dairy products. Switzerland is the home of the famous Swiss or Emmenthaler cheese. The Brown Swiss cattle are large. In this respect they rank second only to Holsteins. They carry considerable flesh. They are hardy, good feeders, and worthy of replacing many of the poor scrub cows now being milked.

The Brown Swiss Cattle Breeders' Association is at Be-

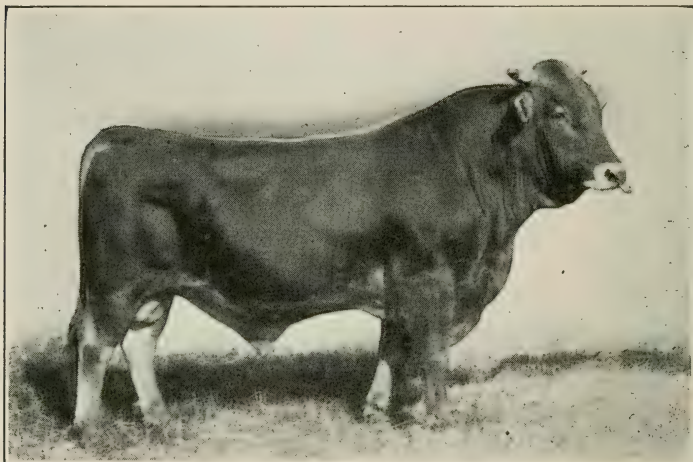


FIG. 28—Brown Swiss bull, Reuben 2927.

Lot of Lake View 3950
Dropped Feb. 24, 1912
Grand Champion bull at the
Iowa and Wisconsin State
Fairs 1917

Reuben 2927
Four daughters in R. P.
with average of 455.69
lbs. fat at an average
age of two years and
three months

Lottie G. D. 3530
Official records: 17,595.3
lbs. milk, 664.25 lbs.
fat.
1st prize at National
Dairy Show 1916

Junker 2365 (Imp.)
Six daughters in R. P.

Reh 3456 (Imp.)
Official record of 12,912.6 lbs.
milk and 456.06 lbs. fat

Forestville Prince 2045
Two daughters in R. P.

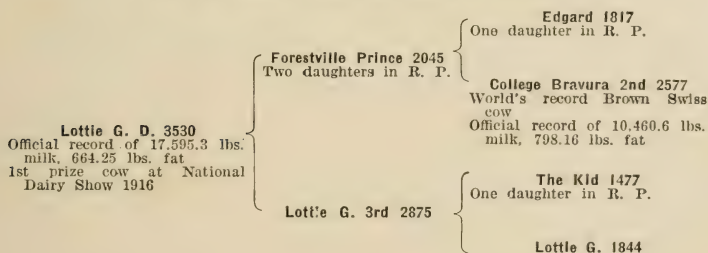
Lottie G. 3rd 2875

loit, Wisconsin, where additional information regarding this breed may be obtained.

College Bravura 2d 2577, owned by Michigan Agricultural College, Michigan, is the champion cow in this breed. She produced in one year 19,460.6 pounds of milk and 798.16 pounds of butter fat.



FIG. 29—Brown Swiss cow, Lottie G. D. 3530.



The Dutch Belted cattle were imported from Holland. In the United States they have not as yet distinguished themselves as very large milk and butter fat producers. These cattle are not large of form. They have never gained much of a foothold in this country. The white belt around their body is typical, and when the whole herd is grazing, their appearance is attractive.

The Dutch Belted Cattle Association has its headquarters at Covert, Michigan.

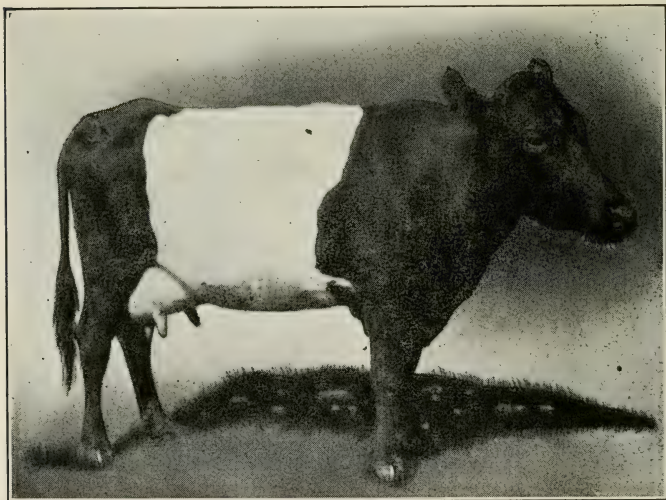


FIG. 30—Dutch Belted cow, Fair Lily 965.

The Red Poll breed of cattle is claimed to be the typical general-purpose breed. The individuals of this breed are smooth, and have a refined appearance. Some individuals and strains are good dairy cows. Those who have shown Red Poll cattle at our large state fairs in competition with the beef breeds have learned that the dairy type, or dairy form, is not winning points in the beef cattle showing. As a consequence, some breeders have emphasized beef qualities. The Red Polled cattle have the advantage of being without horns. They are dark red in color and were imported to the United States from England.

The Red Polled Cattle Club of America is at Gotham,

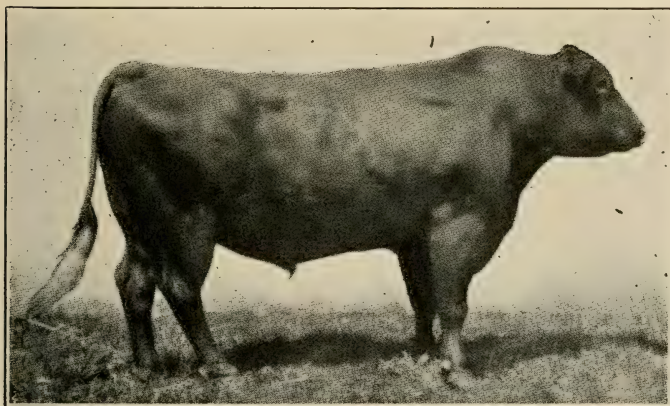
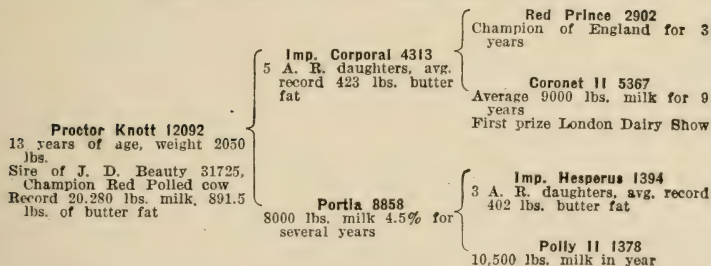


FIG. 31—Red Poll bull, Proctor Knott 12092.



Wisconsin, at which place further information regarding this breed may be obtained.

The champion Red Poll cow is Jean DuLuth Beauty 331725, owned by Jean DuLuth Farm, Minnesota. She produced in one year 20,280.6 pounds of milk, and 891.58 pounds of butter fat.

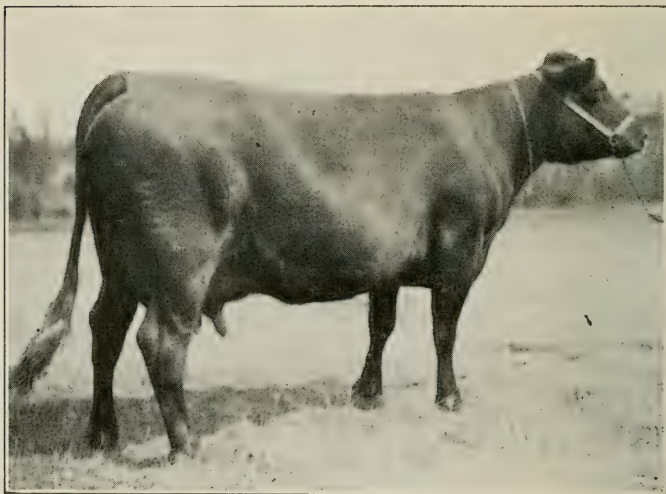


FIG. 32—Red Poll cow, Jean Du Luth Pear 28991.

Jean Du Luth Pear 28991
Dropped Nov. 1, 1907
Record: 16,589.4 lbs. milk,
707.24 lbs. butter fat.
World's record for Red Polls
at time
World's Champion Red Polled
cow for two consecutive year-
ly official tests—1254.24 lbs.
butter fat

Cresco Dav'd 13445
3 A. R. daughters, avg.
record 535.6 lbs. but-
ter fat

Pear 24883
Total for 6 consecutive
yearly official tests:
2587.05 lbs. butter fat
Champion long distance
Red Polled cow
Record for one year
603.66 lbs. butter fat

David 10242
Grand sire of 3 A. R. cows,
avg. 535.6 lbs. butter fat

Cresco Tip 4th 18104
Her sire and sire of her dam
both sired A. R. cows

Imp. Corporal 4313
5 A. R. daughters, avg. record
432 lbs. butter fat

Peach 18901
Dam of Pattie, 435 lbs. butter
fat; Pear, 603 lbs. butter fat

The **Devon** breed of cattle came from England. The individuals of this breed are dark red in color. They are smooth and of good appearance, hardy, and of medium size. It is one of the oldest of breeds. They are generally recognized as more of a beef than a dairy breed. This breed is not common in the United States. The American Devon Cattle Club is at West Chester, Pennsylvania.

The **Shorthorn** breed of cattle is well represented in the central west of the United States, and the Shorthorn blood is found in most of the herds in the central west.

Two classes of Shorthorns are generally recognized: namely, the dairy strain, which is often referred to as the Bates, and the beef strain, frequently called the Cruick-

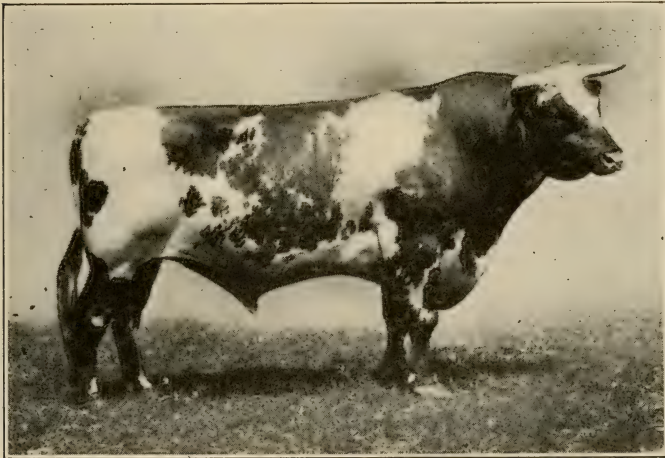


FIG. 33—Dairy Shorthorn bull, General Clay 255920.

General Clay 255920 30 daughters in Record of Merit	{	Imp. Duke Buttercup 160769	{	Duke of Kirby 17th 160774
		19 daughters in Record of Merit		Duchess Butterfly V.45-297E
		Mamie Clay 2d V.48-342	{	Cecil Palmer 133376
		13,232 lbs. milk in one year		9 daughters in Record of Merit Mamie Clay V.38-482



FIG. 34—Dairy Shorthorn cow, Mamie's Minnie.

	{ Duke of Granville 186290		
Mamie's Minnie	{	Mamie Clay 2d	{ Cecil Palmer 133376
Record: 16,201.7 lbs. milk, 575.3 lbs. fat			
			Mamie Clay

shank or the Scotch. While there are some good milking Shorthorns among the Scotch, most of the best milking Shorthorns are found within the Bates strain.

The milking Shorthorns are quite common in England, and are used there extensively for dairy purposes. In that country, breeders pay much attention to keeping up the milking qualities.

During the last two decades there has been a tendency to use chiefly the beef type of the Shorthorns in the United States. The Shorthorn Association of America has favored the beef type rather than the dairy type of the Shorthorns.

Years ago there were more good milking Shorthorn cows than there are today. The few herds of dairy Shorthorns left in the United States have not been able to keep up the milking characteristics of the breed.

If this particular breed is going to be selected for milk production, great care should be exercised in order to obtain representatives of the milking Shorthorns.

Recently the Shorthorn Association of America organized a register for dairy Shorthorns having produced a certain amount of milk during a year.

On account of the great variation within the breed, it is impossible to get an average size or an average production.

Their color is red, roan, white and red, and even pure white.

The dairy Shorthorn cattle produce milk of average richness, containing about four percent of butter fat.

Further detailed information may be obtained from the American Shorthorn Breeders' Association, 13 Dexter Park Avenue, Chicago, Illinois.

The American Dairy Shorthorn Cattle Club has its central office at Burg Hill, Ohio.

The French-Canadian, the **Dexter**, and the **Kerry** cattle have not attained much of a foothold as yet in the United States. The offices of the American Kerry and Dexter Cattle Club are maintained at Columbus, Ohio.

The American French-Canadian Cattle Breeders' Association has its headquarters at Milford, New York.

CHAPTER IV

VALUE OF INDIVIDUALS IN THE DAIRY HERD

Many factors enter into establishing the value of a dairy cow. It is evident that a herd of dairy cows may be, as a whole, valuable and profitable, and yet there may be individuals in that herd which are not profitable. The value of each individual cow may vary according to who owns her, or according to the skill applied in bringing out the best qualities in her.

Certain qualities in a particular cow may appeal more strongly to one person than they do to another. To facilitate the study of the value of a dairy cow, we may conveniently employ the following chief heads:

I. Economic value.

1. Ability to convert feed into milk and milk solids profitably.
2. Value of calf.
3. Value of manure.
4. Value of feed consumed.
5. Number of years of profitable performance.
6. Amount and distribution of labor.
7. Beef value at end of dairy usefulness.
8. Amount of investment in cow.
9. Amount of investment in barn and milk house, milking machine, and other dairy utensils.
10. General expenses.

II. Æsthetic value.

1. Appearance.
2. Disposition.

Economic Value

The financial and economic value of a dairy cow does not, as a rule, receive the analytical study and attention which its importance demands. Many cow keepers, as dairying is now practiced, breed, feed, milk and care for cows continuously without making any efforts towards ascertaining what financial returns each cow in the herd is making. As a consequence of this neglect, relatively few improvements are being made in the productiveness of dairy cows, and many dairy cows are kept at a very small profit and even at a loss, and the dairy industry is thereby discouraged and the mass of consumers complain of the high cost of dairy products.

Ability to convert feed into milk and milk products.—

Milk is the most valuable product from the dairy cow. Quality as well as quantity of milk should be considered. Inasmuch as butter fat constitutes the most valuable commercial constituent of milk, and since the rest of the milk solids, protein, milk sugar, and minerals, are usually utilized in the form of skim milk, the value in this discussion shall be based upon the amount and value of butter fat and skim milk.

The keeping of a dairy cow means the investment of a certain amount of money. The profitableness of this investment is determined by the money the cow can return annually above the expense of feed, care, shelter, interest, depreciation and risk. Some cows make no returns on the investment, many make small net returns, and some make large annual net profits.

Granting that the owner gives good care and feed, the amount of the net profit depends largely on the kind of a cow. With few exceptions, it is reasonable to assume that the different kinds of cows are to be found in all dairy herds. This is, therefore, a large field in which to work for the improvement of dairy herds.

The following statement has been prepared from the records of two cows under the author's supervision. The commercial or market value of these two cows is about one hundred dollars and seventy dollars respectively.

COW NO. 1			
Hay, 1.9 tons @ \$7.....	\$13.30	480 pounds of fat @ 30c.....	\$144.00
Silage, 2.5 tons @ \$5.....	12.50	13,000 pounds of skim milk @ 25c per cwt.....	32.50
Grain mixture, 3750 pounds @ 1c	37.50	Calf	10.00
Pasture, four months.....	4.00	10 tons of manure @ \$1.50...	15.00
Labor	25.00		
Depreciation on cow per year (eight years)	9.40		
Interest on \$100 @ 8%.....	8.00		
Interest on barn investment (\$1000 for 30 cows).....	2.66		
Depreciation on barn per cow per year	1.60		
Risk or insurance on barn....	.42		
Risk or insurance on cow....	.45		
Service fee	2.00		
General expenses (veterinary, medicine, etc., bedding)....	5.00		
Total expenses	\$121.83		
Total net profit.....	79.67		
	\$201.50		\$201.50

COW NO. 2			
Hay, 1.8 tons @ \$7.....	\$12.60	148 pounds fat @ 30c.....	\$44.40
Silage, 1.7 tons @ \$5.....	8.50	3200 pounds skim milk @ 25c per cwt.....	8.00
Grain mixture, 1183 pounds @ 1c	11.83	Calf	5.00
Pasture, four months.....	4.00	8 tons manure @ \$1.50.....	12.00
Labor	25.00		
Depreciation on cow per year (eight years)	5.62		
Interest on \$70 @ 8%.....	5.60		
Interest on barn investment (\$1000 for 30 cows).....	2.66		
Depreciation on barn per cow per year	1.60		
Risk or insurance on barn....	.42		
Risk or insurance on cows....	.30		
Service fee	2.00		
General expenses	5.00	Total loss	\$69.40
Total expenses	\$85.13		\$85.13

The value of the produce from dairy cows is difficult to fix, as it varies under different conditions and in different localities. This is especially true with reference to butter fat. These two cows, the records of which appear in the above tables, freshened in the fall, and the price received

for the butter fat averaged a little more than thirty cents per pound. The price used in making the above statement is thirty cents, which represents the figure obtainable under average conditions.

The average value of 25 cents per 100 pounds for skim milk for feeding purposes is a conservative price. According to experimental evidence, for general feeding purposes to calves and pigs on the farm, 100 pounds of skim milk equals the value of one-half bushel of corn. For instance, if the market value of corn per bushel is 50 cents, then 100 pounds of skim milk is worth 25 cents. Another rule for obtaining the value of skim milk for feeding purposes is that 100 pounds of skim milk equals five times the value of one pound of hog, live weight. If hogs are worth eight cents per pound, then 100 pounds of skim milk have a value of 40 cents.

Skim milk fed to young pigs, or to chickens, may be made to bring as much as 75 cents per 100 pounds. The above price is considered to be the average value for feeding ordinary calves and stock hogs on the farm.

Value of calf.—The commercial value of the ordinary grade calf from different cows is also difficult to determine. The calves, be they male or female, from the poorest cows in the herd are not worth more than they will bring for veal. This is about eight cents per pound. Usually a calf cannot be sold for veal until he is at least four weeks old. The weight of a calf at this age varies a great deal, according to parentage and according to the manner in which he has been cared for. Probably the average weight is about one hundred pounds. Such a calf is then worth about \$8.

The male calves from the good grade cows belong in the same class. In some instances, the male calves from the best cows and sired by pure-bred dairy sires are used as herd headers. This is a mistake. If they are not raised as steers, they should be sold as veal.

The female calves from the best producing cows and sired by a good, pure-bred, well-selected sire are worth

considerably more for raising and for replacing other cows in the dairy herd. Such a grade heifer may be worth twenty dollars.

Granting that 50 percent of the calves are females, the average value of the calves from the good grade dairy cows, if properly sired, is about \$10 when they are about two weeks old. This is the value given in the above statement, page 64.

It is apparent that pure-bred calves, especially when their ancestors are large producers and of good type, are worth a great deal more. Several cases are on record where one pure-bred calf sold for as much as twenty thousand dollars. The value of a calf, then, may be considered to vary between five dollars and the above.

Value of manure.—In the above statement, the value of the manure has been fixed at one dollar and fifty cents per ton. Calculating on the basis of the composition of cow manure, and the value of artificial fertilizers, it is worth two dollars per ton. The former price, however, has been set as more nearly correct. There are always some leakages of fertility which cannot be conserved and utilized. The total quantity of manure voided by different cows varies according to amount and quality of feed eaten and according to completeness of digestion. In the above statement, the quantity of manure voided by each of the two cows represents estimates based upon experiments conducted at the Pennsylvania station.

Value of feed consumed.—The feed consumed by the two cows referred to was carefully weighed, and the figures showing the quantity of feed eaten are accurate to the pound. The value given the grain and hay is also the price actually paid. The value of silage, \$5 per ton, is estimated.

The value of feed varies in different parts of the United States. This is especially true with reference to the rough feed, especially hay. The value of rough feed may even vary greatly within one state. For instance, in western South Dakota alfalfa hay for many years past has been

selling for about \$5 per ton in the stack and about \$7 per ton in bales, while in the eastern part of the state good alfalfa hay sells for \$10 to \$15 per ton. The author has observed that in the central northwest rough feeds are relatively cheap—the price of hay usually ranging from \$6 to \$12 per ton. In the eastern part of the United States hay frequently sells at from \$12 to \$20 per ton. This variation in price of feeds is an important item in considering the cost of keeping a cow; and, therefore, in calculating the profits from a cow it is clear that the greater the cost of feed, the more the cow needs to produce, in order to be a profitable animal. The feed cost represents about one-half of the expenses of keeping a cow.

Special attention is directed to the figures in the above statement showing comparative cost of keeping cows of different producing capacities. For instance, the cost of keeping cow No. 2, which produced \$69.40 worth of produce, is \$85.13, while the cost of keeping cow No. 1, producing nearly three times the value of products (\$201.50), is not three times as great, as at first thought one might expect, but is only \$121.83. In other words, cow No. 1 produced \$132.10 worth of produce more than No. 2, and it cost only \$36.70 more to feed and care for this cow. It costs more to feed a good cow than it does a poor one, but this cost does not increase in proportion to the increase of products. There is but one body to maintain in each case. In one instance, there is a living machine with greater efficiency and capacity. In the other case, this machine for transforming feed into dairy products has less capacity and efficiency. The food for body maintenance, or the food that supplies the energy and keeps the various organs of the body in operation varies but little in different dairy cows kept under similar conditions, while the portion of the food used by the cow for production varies about in proportion to the amount given by the cow.

The St. Louis World's Fair cow demonstration test is one of the largest and most authoritative public cow tests

of its kind that has been conducted. The test lasted one hundred and twenty days. Twenty-five Jerseys, 15 Holsteins, five Brown Swiss, and 24 Shorthorns, a total of 69 picked cows, chosen according to dairy excellence and representing the different breeds, were entered in this test. This test and others, demonstrational and experimental, show results similar to those in the statements. It costs but little more to feed a good cow than it does to feed a poor one.

In the St. Louis cow test, the difference in the cost of feed consumed by the best and poorest Jersey cows was \$1.76. The difference in the value of dairy products from the same cows was \$29.17.

The difference in cost of feed consumed by the best and poorest Brown Swiss cow was \$1.28, while the difference in the value of dairy products was \$12.54.

The difference in the cost of feed between the best and poorest Holstein-Friesian cows was \$1.90, while the difference in value of dairy products from the same cows was \$36.09.

The difference in cost of feed between the poorest and best cows in the Shorthorn breed was \$5.78. The difference in value of dairy products from the same cows was \$31.29.

These figures are not cited to show the difference in breeds. There are factors which would affect the above results. For instance, some of the cows might have been on full feed previous to freshening, and therefore in good flesh. It is evident that a cow in such condition, if of right dairy temperament, would produce more dairy products from less feed than would a cow which was just in ordinary flesh at the time the test began. The data, however, uniformly shows how important it is to emphasize large production of individual cows in the herd.

The following table shows the highest and lowest producer in three different herds of Jersey cows reported by Prof. F. Rasmussen of the New Hampshire station in Bulletin No. 2.

Herd	Cow No.	Milk	Fat	Feed cost	Profit	Cost 100 lbs. milk	Cost 1 lb. fat	Return for \$1.00
A	1	12,275	463.5	\$106.80	\$119.00	\$0.87	\$0.23	\$2.12
	2	1,540	60.4	44.73	15.38	2.90	.74	.66
B	3	9,773	351.2	96.21	76.88	.98	.27	1.80
	4	3,824	155.3	69.28	5.15	1.81	.45	.92
C	5	8,410	307.3	83.58	65.11	.99	.27	1.78
	6	4,845	227.3	73.83	16.44	1.52	.32	1.22

Cow No. 1 equals seven like No. 6 in profit.

Cow No. 5 equals four like No. 6 in profit.

Cost of labor.—The labor necessary to care for a dairy herd properly is an important item of expense. The cost of labor per cow varies according to the kind of dairy farming.

If dairying is carried on with a view to supplying milk and cream for city use, or direct consumption, the cost of labor is relatively great. When milk is produced under such conditions, all surroundings must necessarily be kept up to a high standard. The milk and cream produced for small children and for the tables must be of the highest quality possible. In fact, city ordinances and city inspectors often make certain ideal conditions mandatory. For instance, the stables must be washed out daily. The cows are tested once each year for tuberculosis. The herd is examined about every month by a veterinarian. No new cows are permitted to be brought into the herd unless they are first tested for tuberculosis, and have otherwise undergone a health examination. In connection with such a milk plant, the milk is probably clarified. The milk is bottled and properly cooled before delivery. In addition, it is necessary to produce a uniform supply of milk during the whole year. Dairying in this case cannot be niched in with other farm work. It can readily be seen that milk production under such conditions requires more labor, and more costly labor, than is necessary under any other system of dairy farming.

The cost of labor on the average dairy farm is much less. There are many farms where the additional labor needed for the cows costs no more than if no cows were kept. Under such conditions, the cows are milked and cared for

in connection with other chores, in the morning before the day's work in the field is begun, and in the evening when the work in the field is ended. In the past in the central northwest, dairy farming has been carried on largely in accordance with this system. This method of caring for the dairy herd, however, is gradually changing. Farmers are realizing that to feed and care for the dairy herd is just as much of a day-time business as to do any kind of field work. It is the above system that has caused so much labor to be dissatisfied with dairy farming. Much farm labor discriminates against the farmer who has cows to milk. This is not because the laborers do not like the work connected with cows, so much as it is that the milking and other chores are often imposed upon the help at the time of day when other laborers on grain farms are entirely free from duties. If business methods are applied in the selection and keeping of dairy cows, a farmer can afford to pay for labor to take care of the dairy herd during seasonable hours of the day.

There are very few farmers in the central northwest who keep more cows than can be taken care of with the normal amount of help needed for running the farm. The prudent dairy farmer plans on distributing the work on the farm throughout the whole year. He does not aim to have his cows freshen in the spring at the same time that his crops are to be put in. He does not plan to have the little calves to feed, and the cows to milk the greatest flow during the summer months, when most of his work needs to be done in the field. The wise dairy farmer plans to have his herd of cows freshen in the fall. The help needed for crop production during the summer can then be kept throughout the winter months. If dairy farming is carried on by this method, a good man, with reasonably handy and up-to-date barn equipment can take care of about thirty cows. Such a man receives about \$50 per month. It may then be said that under average farm conditions the expense of caring for one cow per year is about \$25, allowing \$5 per year per

cow for extra labor. These are the figures used in obtaining the data in the above statement.

Beef value of cow.—A healthy dairy cow having a normal constitution always has two values, one for dairying, and one for beef. The dairy value may be obtained day by day and year by year. To realize on the beef, it is necessary to slaughter the cow. When the dairy cow is young, after her first freshening, she possesses the highest dairy value, not because she is then the most profitable performer, but because she has the best period of dairy usefulness before her. It is generally recognized that a dairy cow is at her best when she is about seven years old. The length of a dairy cow's usefulness varies with different cows. In the herd of which the author has charge, there are cows that are fifteen years old and have been profitable performers for about thirteen years. This, however, does not represent the average. The average duration of a dairy cow's usefulness for dairy purposes is about eight years. It probably is not wise to keep the average grade cow till she is physically unable to perform dairy work. The last couple of years of a dairy cow's usefulness, her teeth and other digestive organs are usually not efficient. Generally speaking, it is well to dispose of a cow to the block while she is still in good physical health. This may not apply to a good pure-bred cow. The calf from such an individual would be worth more than the cow would be for meat.

Considering, then, that eight years is the length of a cow's dairy usefulness, after about 10 years such a cow possesses only a beef value. It therefore follows that the dairy value decreases with age. The difference between the sum of the dairy and beef value after her first freshening and the beef value at the end of the cow's dairy usefulness would represent the depreciation of the dairy cow in value. This depreciation is distributed over eight years. Cow No. 2, which has a beef and dairy market value of about \$70 when young and a beef value of \$25 after her period of dairy usefulness is over, depreciates \$45 in eight years, or \$5.62 a year.

Cow No. 1, which has a total commercial value of \$100 when young and a beef value of \$25 at the close of her eight years of dairy usefulness, depreciates \$75 in the eight years, or \$9.40 a year. In purchasing a dairy cow, this question of depreciation in dairy value with age should be considered. At times, the commercial value of a dairy cow near the end of her dairy usefulness is high, and dairymen can thus often obtain a good price for such individuals. The beef value of a dairy cow varies considerably, according to the size and the condition of the cow at time of sale.

Interest and depreciation.—The dairy farmer has considerable capital invested in dairy cows and other dairy and barn equipments. The use of money is worth a certain amount, and in reckoning the cost of keeping cows, the interest on the investment should be properly considered and charged against the cow. The point may be raised that if interest on cow investment has to be charged to the cost of keeping, it is equally fair to include also the interest on the investment in implements for the cultivation of crops. Some authorities have considered the cost from this double viewpoint.

As previously mentioned, the dairy cow is considered as a means through which crops are marketed. Viewing the subject from this standpoint, we see that only such things as are essential in keeping, feeding and caring for the dairy herd and milk should be included.

The money invested in the two cows referred to in the above statement is \$100 and \$70 respectively. Strictly speaking, the principal invested in each of the two cows decreases only by \$9.40 in the first instance and \$5.62 in the second per year. In the first instance the interest would therefore decrease at the rate of 75 cents on the investment and in the second at the rate of 45 cents per year. The expense of keeping these two cows would be reduced by this sum each year during the eight years. At the end of the eight years, the above value, plus depreciation and interest, should at

least equal the invested sum and earnings at eight percent in any other investment.

It is essential to have suitable barn room for the dairy herd. Therefore, the interest on barn investment and barn depreciation should be charged against the cost of keeping the cow. A suitable barn for 30 head, which would probably mean about 20 milk cows, with hay room above, can be built for about \$2000. It is fair to charge half of this against the cows and the other half against the storage of feed. The amount of barn investment chargeable against each of the 30 head of cattle is \$33.33. The annual interest at eight percent equals \$2.66.

Such a barn should last at least 20 years, and if properly painted and kept in repair, should last longer than this. Five percent annual depreciation should then be charged against the cost of keeping the dairy cow, which would amount to \$1.60 per cow per year.

There is also a certain risk involved, against which the dairyman should be protected. Insurance may be carried on the cows at the rate of \$2.25 per \$100 valuation for five years, which would amount to 45 cents annually on cow No. 1 and 30 cents on cow No. 2.

The rate of barn insurance is about \$12.50 per \$1000 for three years, and would therefore amount to about 42 cents per cow per year, which is also charged against keeping a dairy cow.

General expenses.—In addition to the fixed charges, there are a number of general expenses in connection with running the dairy herd which are difficult to estimate definitely. Usually there is some expense for veterinary service and for medicine. There are general expenses for perishable utensils, such as pails, cans, and other sundries.

Bedding is another item which has not been considered in the cost of keeping a cow. In South Dakota, conditions at the present time are such that bedding can be obtained for the hauling. This same condition probably prevails throughout the entire west and northwest. On most farms there is

plenty of straw which can be used for bedding which otherwise would go to waste. It is, of course, different in the eastern part of the United States, where it is necessary to buy bedding.

Service fee.—Maternity is the chief incentive to milk production. It is, therefore, proper that the service fee should be charged against the cow. In the middle west it costs about \$30 per year to feed a sire. If 20 calves are sired annually, this would amount to \$1.50 per calf, considering also interest on the investment in sire, the depreciation in value of the sire, the taxes, and the small percentage of loss in calves, the total charge for service fee is placed at \$2 per cow per year.

These various items of expense vary under different conditions and according to the kind of dairy cows kept. The figures in the above statement and discussions refer to grade dairy cows. Pure-bred and registered dairy herds are necessarily more expensive to care for. There are more records to be kept. The individuals in the herd are more valuable and more money is invested. For this additional labor and invested capital in pure-bred cattle the dairyman receives higher prices for the calves. The average price paid for a pure-bred calf up to one year old, coming from high-producing ancestors, is approximately \$100 to \$200. Some sell for a lower price. Others, again, sell for much more.

The following data shows the fixed charges of keeping a cow per year, from Bulletin No. 145, Massachusetts station, by J. G. Lindsey:

1. Barn for housing cow and feed (per cow)-----	\$75.00	
Interest, taxes, depreciation, repairs and insurance, 10% -----		\$ 7.50
2. Value of cow-----	\$75.00	
Interest and taxes, 7%-----		5.25
Depreciation, 15% -----		11.25
3. Value of barn tools, dairy implements, and the like; per cow -----	\$7.62	
Interest and depreciation, 15%-----		1.15

4. Value of perishable tools and supplies, per cow (cards, brushes, record sheets, soap, salt, ice, bedding, veterinary service, etc.)	9.00
5. Cost of pure-bred bull, per cow	4.00
6. Care of cow and milk for one year	35.00
	\$73.15

Prof. Lindsey found that it cost on an average \$90.04 to feed a dairy cow, 37.4 percent being the cost of grain and 62.6 percent the cost of roughage.

Fixed charges, other than feed, of keeping a dairy cow per year, as reported by Trueman in Bulletin No. 73, Connecticut station, are as follows:

Bedding, for one year	\$ 5.00
Keep of bull, per cow	3.00
Labor per year, per cow	33.60
Interest on money invested in cow and barn	6.75
Taxes on cow and barn	1.25
Insurance on barn	.40
Depreciation of cow (yearly)	13.00
Light, heat, medicines, disinfectants, veterinary service, and ice	2.00
	\$65.00

The following is the fixed charge, not including feed, for keeping a dairy cow one year, Bulletin No. 2, New Hampshire station, by F. Rasmussen:

Labor, per cow	\$32.33
Milking	\$12.60
Handling milk and cleaning utensils	2.73
Care of cow	17.00
Delivery of milk, per cow	7.18
Housing, per cow	9.05
Interest on \$2000 barn @ 5%	\$100.00
Taxes on buildings	15.90
Insurance, 1-3% per year	5.00
Repairs and depreciation, 3% on total value	60.00
For twenty cows	\$180.90
For one cow, per year	\$9.05
Depreciation, per cow	8.91
Bull service, per cow	3.79
Taxes and interest, per cow	4.55

Veterinary services and medicine, per cow-----	.87
Bedding, per cow-----	4.00
(About 18 bales shavings per cow per year-----)	\$5.30,
or about 200 bushels of sawdust @ 2 cents-----)	\$4.00)
Ice and fuel, per cow-----	2.17
Perishable tools, utensils, and salt, per cow-----	.53
Expense of cow testing association, per cow-----	1.40
Total expenses of one cow per year-----	\$74.70

Prof. Rasmussen found the cost of feed per cow to be \$73.03. Cottonseed meal is valued at \$32 to \$36 per ton, bran \$27 to \$30, gluten \$27 to \$35, corn meal \$22 to \$33, mixed feed \$30 to \$33, Ajax flakes \$31 to \$36, dried beet pulp \$27 to \$28, timothy hay \$15 to \$20, mixed hay \$15 to \$18 per ton.

Fixed charges, not including feed, of keeping a dairy cow per year, according to Minkler, 1909 report of New Jersey station, are as follows:

Labor (one man for 12 cows) at \$1.50 per day-----	\$43.00
Bedding (one bale shavings for 20 cows per day)-----	5.29
Stabling -----	5.00
Interest, 5% on \$100 (value of cow)-----	5.00
Depreciation in value of cow, 10% per cow-----	5.00
Bull (\$200 at 5%, \$10; cost of keep, \$50), per cow-----	1.93
Average per cow per year-----	\$70.22
Average per cow per day-----	\$0.192

From the above study one may conclude that the feed cost represents about one-half of the expense of keeping a dairy cow.

The late Director Voorhees of the New Jersey station calculated the cost of keeping a cow from a different viewpoint, as follows:

STATEMENT

Investment:

Farm, 100 acres-----	\$7,500
Dairy barn -----	1,000
Dairy house -----	1,000
Dairy apparatus -----	500

Dairy tools and implements-----	1,500
Horses (three teams)-----	1,500
Cows (40 @ \$75 each)-----	3,000
One bull -----	100
	\$16,100

Annual running expenses:

Labor (3 men @ \$500) in barns-----	\$1,500
Labor (1 man and boy) in dairy-----	750
Labor (2 men with teams)-----	1,000
Depreciation in value of horses, 10%-----	150
Depreciation in value of cows, 10%-----	310
Depreciation in value of tools, implements, etc-----	200
Taxes, insurance, and depreciation in buildings-----	150
One-half cost of feed-----	1,720
	\$5,780
Interest on capital @ 5%-----	805

Total annual expense, including interest-----\$6,585

No charge was included for all feed that is produced upon the farm, as this was accounted for by including the expense of help and teams.

He figures that 7500 pounds of milk is the average annual production of a dairy cow, and that 100 pounds of milk cost \$2.20, and a quart 4.83 cents. No charge is made for supervision, the owner being considered a full hand. According to this, the total income from the milk of the 40 cows would be \$6750.

Æsthetic Value

There are certain highly valued characteristics in a dairy cow, indeed in any animal, aside from her ability to produce. These qualities are difficult to name and describe. Cow owners usually have one or more cows in the herd which they especially favor. They are the pets. They are, many times, protected and cared for even in preference to other cows which are more valuable producers. These characteristics may be largely sentimental; they may refer to her manner or ways, to her form, to her color, to her disposition, production, intelligence and general beauty.

In some instances, this value is so great that it cannot be measured in terms of money. One cow of which the author knows is a small, nervous, alert and bright-eyed cow. She will fight any stranger who happens to walk into the yard. Her keeper, or those who are acquainted with her, can do almost anything with her. The owner takes a pride in this fighting quality, and he will not set a sales price on her.

Other cows, again, are prized because of their gentleness. A certain man owned three cows which were so gentle that the children in the family used them as their playthings. The pasture was near the house and the three boys would ride them to and from pasture. The owner of these cows was wealthy and they could not be bought for any reasonable sum. Disposition in a cow often is of value.

In some instances, an unusual color, or some other peculiarity, will appeal to the owner.

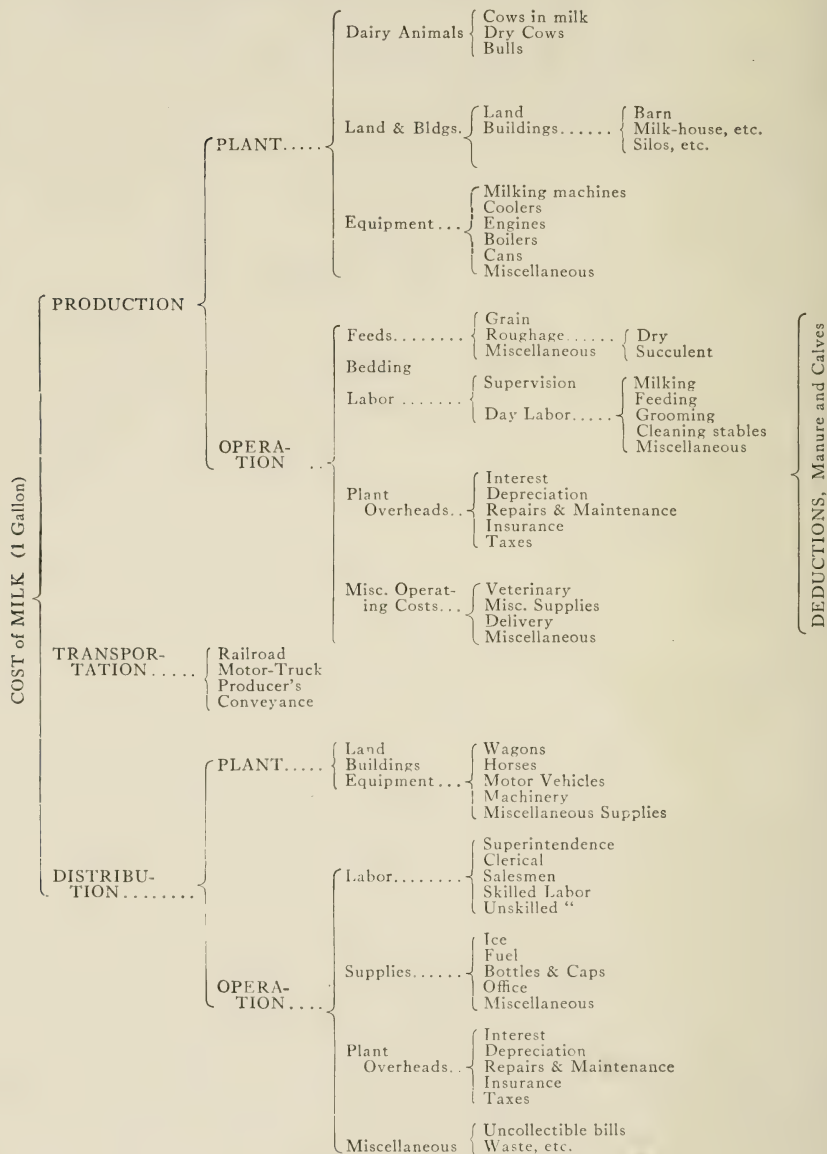
It is not necessarily the most beautiful and symmetrical cow which has the greatest æsthetic value. Frequently it is the oldest and most homely cow on the place that is most highly prized. Usually this is because there is some sentiment connected with her. Perhaps the cow was the first one owned by the dairyman. Maybe she supplied the family with milk and butter during specially hard times, and maybe this particular cow is the foundation of the owner's present whole herd.

Undoubtedly the great majority of dairy farmers value their cows according to what money they can make from them. However, the æsthetic value should not be cast aside. Usually the economic and æsthetic value go together.

Cost of Keeping a Dairy Cow
per Year in Different Sections of the United States

	Illinois (Hepburn)	Minnesota (Peck)	Oregon (Howard)	Washington (Nyström)	Oklahoma (Fuller)	Montana (Martin)	New Hampshire (Rasmus- sen)	Massa- chusetts (Lindsey) Bul. No. 145	So. Dak (Larsen)
Approximate cost of labor. Cost of stabling, including in- terest, taxes, insurance, re- pairs, depreciation.....	\$21.31 7.81 None, due to raise in price	\$22.20 5.32	\$15.00 3.00	\$36.00 7.50	\$30.00 9.00	\$35.00 3.00	Including care of Milk \$32.35 9.05	Including care of Milk \$32.35 7.50	\$25.00 4.68
Depreciation of cow.....	1.25	3.19	4.00	10.00	8.00	8.00	8.91	11.25	9.00
Taxes on cow.....	6.43	.30	.50	1.00	.75	.25	4.55	5.25	.30
Interest on cow investment..	1.00	3.62	3.00	7.50	6.00	2.50	3.79	4.00	6.40
Bull service.....	8.00	2.00	1.00	5.00	3.00	.50	4.00	10.15	2.00
Bedding.....		No record	1.00	4.00	2.00				
		Ice & heat							
		not							
		included							
Veterinary, medicine, disin- fectants, light, heat, ice, etc...	2.69 76.18 Horses 1.27 Equipment 2.86	2.86 33.03	.25 35.50	6.00 65.00	2.00 \$35 to \$40	2.00 40.00	4.97 73.03	90.04	5.00 40.00
Total.....	\$128.81	\$72.52	\$63.25	\$142.00	95.75 to \$100.75	\$91.25	\$140.65	\$163.19	\$94.38

An outline for studying the cost of milk production for city supply, proposed by the Maryland Council of Defense, Dr. A. F. Woods, chairman.



CHAPTER V

DETERMINING THE PRODUCTION OF EACH COW IN THE HERD

From a business standpoint, the profitableness of a dairy cow depends largely upon the amount of milk and the amount of butter fat she produces. These, under average farm conditions, may be determined in two ways:

1. By the appearance of the cow, or by judging the relation of form to function.

2. By weighing and testing the milk and keeping records of the amount and kind of feed consumed.

Appearance of Cow

This method is by no means an accurate one for determining the production of a cow. At times, it is necessary, however, to resort to it—for instance, if a cow is offered for sale at a public auction, or any other place which does not afford opportunities for weighing and testing the milk. The owner's word cannot always be relied upon as to a cow's production, records of production of cows in the average dairy herds are not generally kept, many cow owners do not have the proper conception of what constitutes a profitable production, and some cow owners, in their enthusiasm for getting a good price for a cow, will call a poor cow a good producer.

If the buyer understands the chief points of a dairy cow, the points which indicate large, economical milk production, and can thus couple his knowledge with the statements of the seller, he is in a reasonably good position to select a profitable dairy cow. By this method he is at least able to distinguish a good cow from a poor one. He may not be able to choose the best cow from several cows producing

nearly an equal amount, but he can easily detect a large producing cow from a small producer. The desirable form of a dairy cow has been discussed in detail in connection with the score card. The following brief review, however, may not be out of place.

Form indicating production.—The profitable dairy cow should be deep and wide of body. Especially should she have a deep and wide barrel. She should be wide and level in the hind quarters and broad and open of frame. This gives the cow a wedge shape, which is important in a dairy cow. The wedge shape so often referred to does not mean that a dairy cow should be narrow in the front quarters. She should have normal width and depth in front and should be unusually wide behind. Indeed, it is highly important that a dairy cow should have abundant capacity in the front quarters. Some of the most vital organs of the cow, namely the heart and the lungs, are located here. A cow should have a large and full heart girth, and be deep and reasonably wide in the chest. A cow that is very narrow in the chest region, that is depressed in the crops and in the fore flank back of the shoulder blade is, as a rule, not a cow that possesses a strong constitution.

A deep, long and wide barrel, having an excellent covering, indicates capacity to hold, and efficiency to digest, absorb, and assimilate feed. These are important requisites in a dairy cow. To be able to digest and assimilate a large amount of food is the first important requisite in the formation of milk.

The skin should be loose and pliable. The hair, or covering, should be short, smooth and downy. This indicates good blood circulation and ability to digest a large percentage of the food consumed. The outside skin is an extension of the lining of the digestive tract. This lining contains the glands which secrete the digestive juices. It is on account of this close relationship of the inside to the outside of a cow that quality of skin is of so much importance.

The dairy cow must be able to carry these digested and

absorbed nutrients to the udder, or to the seat of milk manufacture. This ability is indicated by the size, branchiness, length and course of the blood veins on the abdomen of the cow. The size and number of milk wells and the kind and distinctness of the escutcheon, or milk mirror, are also important. The escutcheon should be wide and well defined. The milk veins should be large, long, crooked and branching, especially near the udder, and the milk wells should be large and numerous. Such veins and wells indicate that a large amount of blood flows to the milk secreting glands. The blood carries the raw material from which the gland manufactures the milk.

Probably the most important point of all in the form of a good dairy cow is a large, wide and long udder of good quality and shape. The mammary gland, or the machinery for the manufacture of milk, is located in the udder. The greater the capacity of the udder, the more machinery, or the more gland capacity for milk production, there is likely to be. The udders should be wide and long, extending well forward under the abdomen, and well back up between two flat and well separated thighs. The udder should be wide and level on the bottom and the teats pointing straight downward. The teats should not be too small. They should be evenly placed and not too close together. The udder should be of good quality. A fleshy, hard udder may be large when empty. Such an udder does not indicate milk production capacity. Besides, a fleshy udder is predisposed to inflammatory diseases.

The dairy cow should be symmetrical of build. She should have a clean-cut feminine appearance, large, bright eyes, broad forehead, slightly dished face, large nostrils and muzzle, an intelligent and lively appearing head set on a thin and medium long neck. A dairy cow should have a straight, prominent and open jointed backbone. The loins should not be drooping. They should be wide and reasonably level.

Briefly speaking, these are the essential points indicating

capacity to produce a large quantity of milk. This form, however, does not necessarily indicate high quality, or richness of milk. This latter is much more difficult, in fact impossible, to ascertain by the appearance of the dairy cow. A copious yellow skin secretion and an udder having considerable substance without being fleshy are said to indicate richness of milk. This secretion is most apparent on the inside of the ear and at the end of the tail bone. This yellow color is also apparent on the covering of the udder. A yellow or amber-colored hoof and horn are regarded by some to be indicative of yellow milk and of rich milk. A soft downy hair covering the udder is also said to indicate richness of milk. On some cows this deep yellow color and yellow secretion are apparent on the surface of the skin all over the cow.

To what extent these latter points can be accepted as a guide as to the color or richness of milk, the author is not prepared to state. It has been said that the breeders of Jersey and Guernsey cattle in their respective homes have used these points as guides or indications in selecting foundation or breeding stock to procure richness of milk. It is well known that these breeds as handed down to us excel in producing rich milk, rich not only in percent of butter fat, but also in total solids.

Weighing and Testing Milk from Each Cow

The only absolutely reliable method by which the production of every cow in the herd can be ascertained is to weigh and test the milk. No dairyman should fail to keep records of every member of the dairy herd. From observations this method of keeping track of cows is gaining very rapidly. At first many dairy farmers objected to this method because of the additional detailed thoughts and attention. The amount of work and time necessary for making these records is slight, and still there are dairy farmers dependent upon the cows for their total income who do not realize the importance of record keeping. This

matter of weighing and testing the milk is a business proposition, and should receive the careful attention of every man who markets his field crops through the dairy cow.

Manner of obtaining records.—Both to weigh and to test the milk from every cow after each milking would be laborious for the average dairy farmer. This method is not recommended except in case of official testing for advanced registry, and in connection with experiment station work. Various experiments show that daily weighing and intermittent testing give about ninety-eight percent accurate results.

The various breed associations accept tests from cows if the milk is weighed daily; and weighed, sampled and tested two days out of each month. The weighing, sampling and testing during these two days is to be done by a man appointed by the state experiment station. The weighing of the milk during the remainder of the month is done by the owner or the milker. No composite samples during these two days are accepted. Each milking must be sampled and tested separately. The results from such weighing and testing are termed semi-official tests. Such a test is usually made of pure-bred and registered cows only.

Another method of testing cows is for the owner to weigh the milk daily from each cow. One day out of each month samples are taken from each cow's milk in the herd, and tested for percent of butter fat. The daily weighing is done by the owner or by the milker. The sampling and testing during the month may be done by the owner or the milker, or it may be done by some other person who is not directly interested in the herd. From a public standpoint, the latter would be the most authentic. However, the sampling and testing that are done by the owner are also reliable. No owner would seek to deceive himself or anybody else. If such were attempted, the very purpose of the weighing and sampling would be defeated.

The sampling and testing of the milk from each cow may be done after each milking, or a composite sample

made up from each of the milkings during a day may be taken. In the latter case, it is necessary to test only one sample from each cow, while in the former case there would be as many samples to test as there are milkings from each cow. The composite sample method does away with considerable work. In case the tester is not experienced in handling details, it may also do away with mistakes. The composite sample method is the simplest.

Even though the time required for the daily weighing of the milk from each cow is small, there are still some who do not like to apply themselves to that extent in obtaining records from the dairy herd. For this reason efforts have been made to simplify the weighing, sampling, testing and record-keeping still more.

A very simple and yet satisfactory way to obtain records is to weigh, sample and test the milk from each cow only during one day out of each month. This is as simple a method as could possibly be practiced. If the cows are in normal condition during that one day in each month, this method gives reasonably accurate results. The method has the drawback that if some conditions should make the cow abnormal and the quantity and quality of milk given by the cow should not be normal, the results would not be accurate. On the average dairy farm, however, where heavy feeding is not done and the surroundings and conditions are quite uniform from day to day, this method of obtaining records of the dairy herd is simple and gives reasonably good satisfaction.

The following is a copy of a record sheet for this method of weighing and testing:

Daily Milk Records for the Month of

191

Name of cow							
Date		Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
1.	A. M.						
	P. M.						
2.	A. M.						
	P. M.						
3.	A. M.						
	P. M.						
29.	A. M.						
	P. M.						
30.	A. M.						
	P. M.						
31.	A. M.						
	P. M.						
Total Milk							
% Fat							
Lbs. fat							
Value of products							
Cost of feed							
Income above feed cost							

Monthly Summary of Milk and Fat Records for Year 191_.

[illegible]

Composite samples.—The composite samples should be carefully taken and carefully kept. The person who does this work should be careful to obtain first a sample representing the average quality from the whole milking. This is accomplished by thoroughly mixing the milk from each cow just before sampling. Secondly, the sampler should be careful to obtain a proportionate part of each milking so that when all of the samples from each milking are added together in one bottle they represent the average quality of the milk produced in all of the milkings, whether the sample is taken for two consecutive days or for one day.



FIG. 35 — The use of the scales and the Babcock tester is the surest way of ascertaining the productiveness of each cow in the herd.

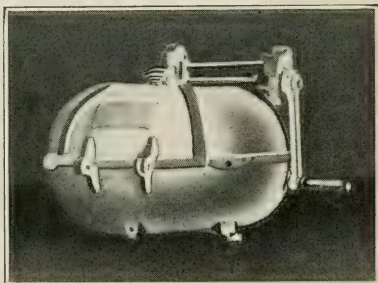


FIG. 36—Enclosed hand tester.

A proportionate sample may be obtained by using a sampling tube, and in this connection a milk pail should be used that has the same diameter from top to bottom. It can readily be seen that if such a sample tube is used, and it is inserted to the bottom of the milk each time, the amount obtained is in proportion to the amount of milk given by the cow. For instance, if a cow gives 40 pounds of milk in the morning and only 20 pounds of milk in the evening, the sample taken for the composite bottle should be twice as large in the morning as it is in the evening.

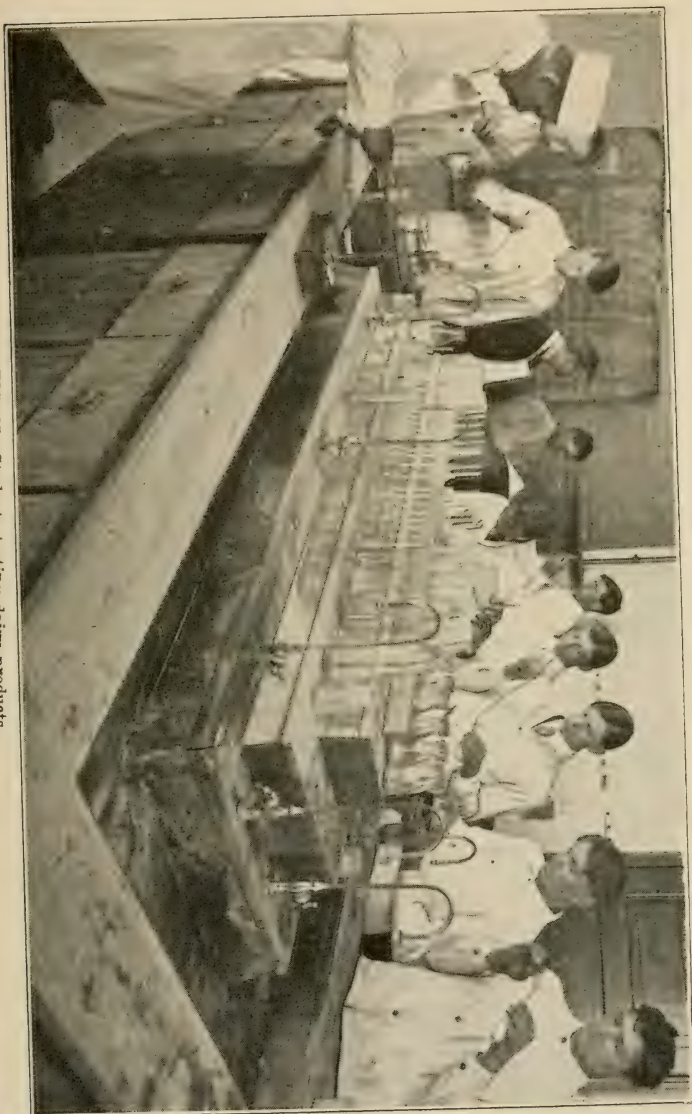


FIG. 37—Students testing dairy products.

Another method by which a proportionate composite sample may be obtained is to use a graduated measure. If a cow gives 20 pounds of milk to a milking, 20 cubic centimeters may be taken out for the composite sample. If a cow gives 30 pounds of milk, 30 cubic centimeters may be taken for the composite sample. This method is practicable when the diameter of the milk pail is not uniform.

Some have persisted in obtaining samples of each milking for the composite bottle by using a small dipper. By the use of a dipper one cannot judge as to the exact amount that should be obtained. Yet in many instances, the dipper method of obtaining samples gives accurate results. This is due to the fact that with some cows there is, practically speaking, no variation in the quantity of milk given from one milking to another, and there may not be any variation in the quality. If the quality of the milk is the same from one milking to another, or if the quantity of milk is the same from one milking to another, no attention need be given to obtaining a proportionate sample. Experience has amply shown, however, that both the quantity and the quality of milk from a cow usually vary considerably from one milking to another. The safest way, then, for obtaining correct composite samples is to be careful, first, to obtain a sample that represents the average quality by thoroughly mixing the milk, and, secondly, to obtain a proportionate part of each milking.

The effect of not obtaining a proportionate sample may be illustrated as follows: Supposing a cow gives in the morning 40 pounds of milk testing 3.2 percent. Then in the evening she gives 30 pounds of milk testing 4 percent.

$$30 \times 4.0 = 1.2 \text{ pounds butter fat.}$$

$$40 \times 3.2 = 1.28 \text{ pounds butter fat.}$$

$$70 \quad 3.6 \quad 2.48 \text{ pounds butter fat.}$$

In case an equal amount, for instance, taken with a dipper, had been obtained for the composite sample from these two milkings, the average test for this particular

month and for this particular cow would be the average of the above two tests on page 92, or 3.6 percent.

By obtaining a proportionate sample of each milking, the test obtained would be the true average of the two milkings, or the same as is obtained by adding the fat together and also the milk, and then dividing the fat by the milk and multiplying by 100. In this case, which is the correct method, the average test for this cow's milk would be 3.5 percent. This makes a difference of about 0.1 percent. In some instances the difference between the morning and night milkings is considerably greater. The greater such difference in quantity and quality, the greater the probability of obtaining errors in connection with sampling of milk from cows.

If the composite sample represents milk from one day's sampling and the testing is done at once, then it is not necessary to add a preservative to the composite sample bottles.

In case that the composite sample represents the milk from two or more days' samplings, a preservative should be added.

Corrosive sublimate tablets and potassium bichromate are convenient and efficient preservatives to add. Indeed, any preservative, added in small amount, that is convenient and efficient may be used. Any of these preservatives is poisonous, and the samples should, therefore, be properly guarded. Corrosive sublimate tablets may be obtained at a nominal cost from any of the creamery supply houses. They are colored pink, so there is little danger that these samples will be mistaken for normal milk.

There should be as many composite sample bottles as there are cows whose milk is to be sampled. These bottles may be conveniently placed on a shelf in the milk or weighing room, or in some other convenient place near the place of weighing and sampling. These bottles should be labeled or numbered to correspond with each cow in the herd. The samples should be tightly covered to prevent evapora-

tion of moisture. Each time the milk sample is added, the composite bottle should be given a rotary motion. This mixes the preservative with the milk. It also mixes the newly added milk with that already in the bottle.

When this composite sample from consecutive milkings has been obtained, it should be tested as soon as convenient. The longer the testing is delayed, the more the sample is likely to dry out, and the more difficult it will be to get it properly mixed, before the sample for the Babcock test is measured out. If the cream has risen and a ring adheres to the inside of the bottle, the sample should be placed in warm water. This will loosen the cream adhering to the bottle.

Testing the samples for fat.—After being assured that the milk is thoroughly mixed, the sample, 17.6 cubic centimeters, is measured out with a pipette and transferred into the testing bottle. To this is added 17.5 cubic centimeters of commercial sulphuric acid having a specific gravity of 1.82. This acid is slowly and carefully added, then mixed at once with the milk. The acid digests all the milk solids except the butter fat. The amount of acid varies some according to the temperature of the milk and acid, composition of the milk, and the strength of the acid. As soon as the acid and milk have been thoroughly mixed the color of the mixture should be dark coffee.

The bottles containing this milk and acid mixture are then whirled for five minutes in the centrifuge; then filled with hot soft water to the base of the neck, and whirled again for two minutes. The machine is again stopped and the bottles filled with soft hot water to such a point in the neck as to permit of convenient reading of the fat. The bottles are then whirled one minute more.

The measuring of the butter fat is usually accomplished by using a pair of dividers. One point of the dividers is fixed at the bottom and the other one at the top of the fat column. The operator then carefully removes the dividers, placing the lower point of the dividers at the zero mark,

the upper part of the dividers reaching up on the scale showing the percent and fraction of a percent of butter fat the milk contains. There are 10 main divisions on the scale, and each one is equal to one percent. Each whole percent is subdivided into five parts, making each subdivision equal to 0.2 percent. The fat column is read from the bottom to the top of the meniscus.

Care should be taken that the test is read at once after whirling before the fat cools and congeals.

In cold weather the last whirling should be short, otherwise the thin column of fat is likely to chill. The testing should not be done in a cold room. However, should it be necessary to test in a cold room, hot water may be added to the tester, and the hand machine may also be thoroughly heated by placing it on the stove before the testing operation is begun.

For rules governing the testing of cows for advanced registry the readers are referred to pamphlets published by the various dairy cattle breeders' associations. These are sent free of charge upon request.

To determine the profit derived from each cow, it is necessary to weigh the feed each cow consumes. The grain at least should be weighed. This will be referred to again under the feeding of a dairy cow.

Cow testing associations.—No matter how simple the method of obtaining records of cows, some labor and attention to details are necessary. Many farmers object to the weighing and testing of the milk on this account. To minimize this work, to put it into the hands of a specialist, to have it done systematically, and as cheaply as possible, cow testing associations have been organized.

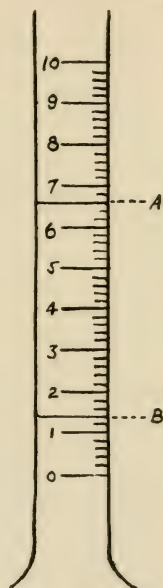


FIG. 38 — Read from bottom of fat column to top of column, or from A to B.

Cow testing associations originated in Denmark. In this little country there are now over 500 associations working successfully. Each one consists of a variable number of dairy farmers living in one community. These dairy farmers go together to form an association, governed by rules and by-laws on which they mutually agree. The officers of the association hire a man to travel from place to place to weigh and test the milk produced by each cow in the various herds, and also to weigh the feed consumed by each cow in the various herds, and make detailed records of same. This official tester usually tests the cows in one herd only, each day. If there are two small herds close together, he may weigh and test the milk for two farmers

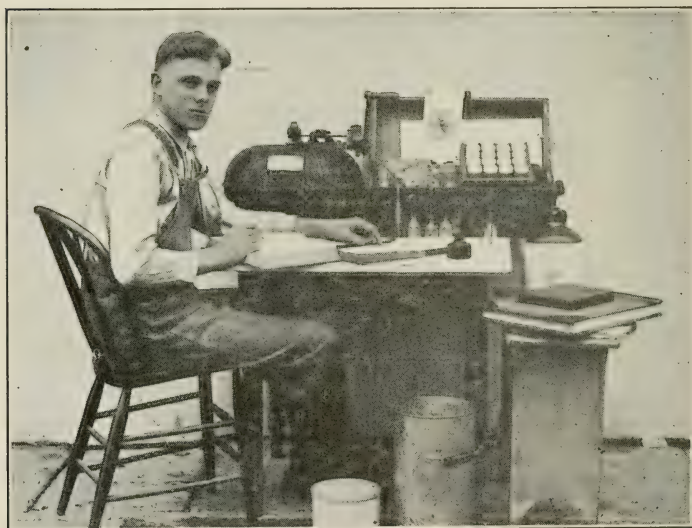


FIG. 39—Cow tester and his outfit. Davenport, Ia., cow testing association. (Courtesy Hoard's Dairyman.)

in one day. It is, therefore, evident that there is room for only about 25 different farmers in one cow testing

association, since there are about 26 working days in each month.

When the tester has obtained records from one farmer's herd, he is taken to the next dairy farmer, and so on till he has made a complete circuit of all of the members. The following month this same circuit is made, and so on for every month.

In some instances this cow tester has a conveyance of his own. In other instances each farmer agrees to take him to the next place.

The first cow testing association was organized in 1895, near Askov, Denmark. The cow testing associations in the United States are modeled after those in that country, although conditions in the United States are different from those in Denmark. The United States is a very large country, representing many different conditions under which dairy farming is carried on. For these reasons, the manner of carrying out the work of a cow testing association varies somewhat in the United States. Three hundred and forty-six cow testing associations are now working successfully in the United States, and new ones are constantly being formed. Wisconsin leads with 51.

The first cow testing association in the United States was organized near Fremont, Michigan, in 1905.

Probably most of the cow testing associations in this country are self-supporting. The average cost to the dairy farmers to have their cows tested through a cow testing association is about \$1.50 per cow each year. The cost varies with the number of cows in the association and the cost to maintain a man and officers to operate it. Where conditions are very favorable, the cost per cow does not exceed \$1 per year.

In portions of the central and northwestern United States, where dairy farming is not carried on intensively, a flat rate has been found to work more successfully than a certain charge per cow. The author now speaks especially of

South Dakota conditions. Where a certain charge is made per cow, there is a tendency for the owner to agree to put into his herd more cows than he actually tests. Towards the end of the year he may sell one or more of the cows entered, and some of the cows he intended to enter in the association are not tested at all. Such a dairy farmer naturally wishes to get out of paying for some of the cows entered. By paying so much per head, the money is not usually paid up at the time the association is started. This makes it rather difficult to finance the association.

If the flat rate method is used, there is little difficulty in continuing the association and in getting the proper financial support. At the time the association is organized the owner's note is taken for the full amount. Arrangements can usually be made with the local banker to cash these notes at any time. No note should be accepted that is not good at the bank. The flat rate may not be more than \$20. Under South Dakota conditions \$25 to \$40 per dairy farmer is needed. If there are about 26 members in the association this levy will bring an annual income of \$650 to \$1040. This amount is necessary to conduct the association. Usually the tester receives from \$50 to \$80 per month and expenses while on the route testing.

Experience has shown that the farmers do not like to consume time to take the tester from one place to another. Better results are obtained by equipping the man with horse and buggy. The farmers do not object to feeding the horse, but in many instances they dislike to be troubled with having to transfer the tester and his outfit.

At the close of the year this tester, on the basis of the data obtained, sums up the production of each cow, and the food consumed by each cow. These results are recorded in permanent books. The monthly production, consumption of food, and profit or loss from each cow, together with other data for the year, may be obtained from these records at any time. Debit and credit sides are kept for

each cow, and the difference between the two determines whether the cow had been kept at a loss or at a profit.

The number of cow testing associations in the United States by states on July 1st, 1916, is shown in the following table (Dairy Division, U. S. Dept. of Agriculture) :

Name of state	Years.											1917
	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	
Michigan.....	1	4	2	5	4	3	4	4	3	3	19	15
Maine.....			3	4	3	6	5	4	5	8	11	5
New York.....			1	1	3	9	18	21	29	35	47	43
Vermont.....				2	8	10	11	17	28	33	38	47
Iowa.....				2	5	4	8	7	8	13	23	30
California.....				1	3	2	4	4	5	7	9	15
Wisconsin.....				9	0	10	8	11	24	37	51	81
Nebraska.....				1	0	0	0	3	2	3	4	4
Colorado.....					1	1	2	1	1	0	0	3
Pennsylvania...					1	1	2	2	7	14	19	24
Ohio.....					1	0	0	1	4	5	20	30
Maryland.....					1	1	3	3	2	4	7	8
Illinois.....					4	3	3	2	7	3	3	17
Washington.....				1	3	1	0	0	1	1	12	18
Minnesota.....					3	7	10	9	11	22	26	26
New Hampshire...					1	1	1	1	4	8	11	12
Oregon.....					1	1	1	1	7	11	15	17
Utah.....					1	0	0	1	1	0	1	1
Massachusetts...					2	2	2	3	0	4	4	4
Virginia.....					2	2	2	0	0	2	4	4
Kansas.....					1	1	1	1	1	1	1	4
Indiana.....								2	2	3	7	9
Kentucky.....								1	1	0	1	1
Missouri.....									2	1	2	5
New Jersey.....									2	3	4	8
West Virginia...									1	1	3	1
Connecticut.....									1	3	6	3
N. Carolina.....									2	0	0	0
Louisiana.....									1	0	0	0
South Dakota...									1	1	3	3
Nevada.....										1	0	1
Arizona.....											2	2
Rhode Island...											2	2
Delaware.....											2	3
Idaho.....											2	1
Mississippi.....											1	0
Montana.....											1	2
Tennessee.....											1	8
New Mexico.....												1
Wyoming.....												1
Total.....	1	4	6	25	40	64	82	100	163	211	346	459

Value of dairy herd records.—The first and chief value accruing from keeping records of milk and butter fat produced and food consumed by each cow is that it shows which cows are good producers and which are poor producers. The poor cows can then be culled out and the female offspring from only the good cows can be retained.

This record keeping is then a basic guide to intelligent, successful breeding and selection.

Secondly, by means of these records the owner is enabled to obtain higher prices for his young stock. He can point



FIG. 40—The poorest producing cow in the Black Hills cow testing association, South Dakota. Milk 2293 lbs., fat 88 lbs.

out the superiority of certain animals of the herd and the inferiority of others, and thereby demonstrate to the prospective buyer the value of a good dairy cow and the importance of selecting good producing parents

and ancestors. In this manner the breeder is able to obtain a large price for his good young stock. There is a great demand for female offspring from cows having good records.



FIG. 41—The highest producing cow in the Black Hills cow testing association, South Dakota. Milk 7129 lbs., fat 330 lbs.

Thirdly, the feeder is able to feed the various individuals in the herd properly. If no records were kept of the produce, there is a strong probability that all of the cows

in the herd would be fed nearly alike. By keeping records, each cow can be fed grain to correspond to the amount of milk and fat produced.

Fourthly, the feeder is able to detect the approach of sickness of the cow. When sickness approaches, the cow will show it first in a decrease in the amount of milk given. She may also show it in a loss of appetite. Oftentimes it means much to be able to detect a sickness at the beginning. It may often prevent prolonged sickness and even the loss of the animal. If a disease is attended to in time, it is much easier to cure than if it is allowed to develop.

Fifthly, the owner is enabled to judge the work of the milker. Large variations in the amount of milk from one milking to another indicate irregularities of the milker or of the cow.

Besides, there is the personal satisfaction of knowing what each cow in the herd is doing. System in any work is not only remunerative and convenient, but it is satisfying.

ADVANCED REGISTRY REQUIREMENTS (lbs.)

Table showing advanced registry requirements for the different breeds of dairy cattle. (lbs.)

Ages		Ayrshire		Brown Swiss		Guern'y	Holstein		Jersey	
		Milk in 365 days	Fat in 365 days	Milk in 365 days	Fat in 365 days	Fat in 365 days	Fat in 7 days	Fat in 365 days	Fat in 7 days	Fat in 365 days
2 yr.	Jr.	6000	250.5	.....	.....	250.5	7.2	250.5	12.	250.5
	Sr.	6500	268.8	6000	222.	.....	.....	.....	.....	.....
3 yr.	Jr.	7000	287.1	.....	.....	287.	8.8	287.	.....	.....
	Sr.	7500	305.4	6429	238.4	.....	.....	.....	12.	287.
4 yr.	Jr.	8000	323.7	.....	.....	323.5	10.4	323.5	12.	323.5
	Sr.	8500	342.	7286	271.3	.....	.....	.....	.....	.....
5 yr.		9000	360.	8143	304.1	360.	12.	360.	12.	360.
6 yr.		.....	.....	9000	337.	.....	.....	.....	.....	.....

CHAPTER VI

INCREASING PRODUCTION OF DAIRY HERD

When the owner has tested the cows in the herd and gets the data systematically recorded, he is in a position to improve effectively and systematically the production, and therefore, the profitableness of his herd.

The improvement of the dairy herd may conveniently be divided into two heads.

1. Improvement of present dairy herd.
 - (a) Culling of poor cows.
 - (b) Keeping up good feed and care.
2. Improvement of the future dairy herd.
 - (a) By buying good cows.
 - (b) By raising good cows.

Improvement of Present Dairy Herd

Cull poor cows.—The author thoroughly believes in giving every cow an opportunity to prove herself worthy of at least paying for her feed and care. This, many cows do not do.

For various reasons some cows may not be economical producers one year and yet the following year and succeeding years they prove to be profitable animals. For instance, some heifers are not large producers. They develop late, but after they have had two or three calves they become excellent cows. Others, again, will do well during the first year and then during the second lactation period they become poor producers. It is not uncommon at all for heifers to have an off year after the second freshening. This may be due to a change of teeth, causing their appetite to be poor. It may be due to overworking the heifer during her first lactation period, and it may be due to incidental and uncertain causes.

To illustrate the importance of culling out poor cows, suppose a man owns 10 cows, and it costs \$40 to keep each cow a year, or \$400 to keep the whole herd a year. By



FIG. 42—A scrub cow, No. 9, in poor condition.

keeping such records as previously referred to, it is found that four of these cows show a gross income of \$35 per year, or a loss per cow of \$5. These cows would cause a loss, then, of about \$20. By culling out these

four unprofitable cows, the \$20 annual loss would be increasing the profits of the remaining six cows. The total profit would then be \$420 from six cows instead of \$400 from 10 cows.

This would equal an annual profit per cow of \$70 after culling, instead of an annual average profit per cow of \$40 before culling. A few poor cows reduce the profits from the good cows. As a rule, the dairy

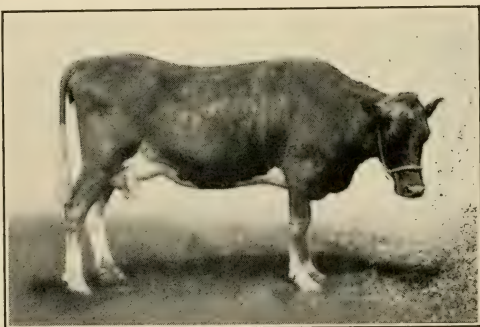


FIG. 43—Scrub cow, No. 9, one year later. Note improved condition. (Ia. Exp. Sta.)

farmer should fatten and sell such poor cows to the butcher, or dispose of them to one who does not milk or who raises cattle for beef purposes.

Good feed and care.—As will be discussed more in detail later, a dairy cow uses her feed for two principal purposes: first, to maintain the body, and secondly, for milk production. In some instances, cows do not receive it regularly and the feeds are not properly balanced.

In some cases, the dairy herd is not properly cared for. At times the dairy herd is forced to "rustle" for feed in the snowy cornstalk field during the cold weather. In other instances, they are compelled to go into hilly and rough-land pastures where it is necessary for them to "rustle" a great deal in order to obtain feed. Under such circumstances cows do not receive enough nourishment to maintain the body and produce milk also.

Some cows are forced to drink ice cold water and to remain out of doors a good share of the time during extremely cold weather.

It has been demonstrated under practical farm conditions, and also in various experiment stations, that the kind of care and feed received has much to do with the amount of production, as well as with economical production from the dairy herd.

At the Cornell station (Bull. 222) Prof. Wing found that a properly selected ration improved the yield of milk and butter fat from a herd of cows about 50 percent over the production of these same cows kept on a farm during the preceding year.

At the Maryland station this point was carefully studied. Two lots of cows were used in the experiment. There were eight cows in each lot. One lot was fed grain throughout the year, while the other lot was not fed any grain at all during pasture season. The object was to feed one lot well and the other lot sparingly. During the experimental period the grain-fed lot produced 27 percent more milk than did the lot that received no grain. During the following season, when both lots were treated in the same manner, the lot that received grain during the previous season produced 16 percent more milk than did the other lot. This increase in

production was laid to the extra feed these cows received during the previous season.

The Iowa station found that good feed and care improve the milk production of common cows 59 percent, and fat production about 54 percent. These and many other examples amply show the importance of good feed and care.

The average cow utilizes about one-half for milk production. If the feed is cut down, it can readily be

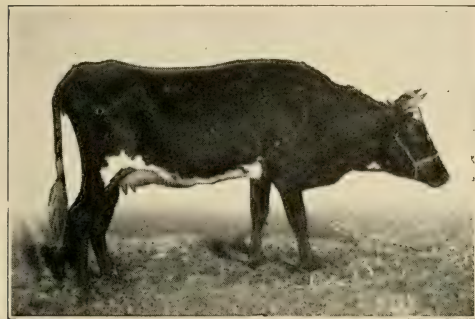


FIG. 44—Scrub cow No. 6. Production 2742.1 lbs. milk, 131.04 lbs. of fat. (Ia. Exp. Sta. Bull. No. 188.)

seen that this will be at the expense of milk production chiefly. If this scantiness of feed is prolonged, or if the feed shortage is cut down still more, eventually the cow will be getting no more feed than is needed for maintaining the body, and very little or no milk will be produced by the cow. Every cow has a certain ability to transform feeds into dairy products profitably. Every



FIG. 45—Scrub cow No. 6 three months later. Production milk 5556, fat 244.79. (Ia. Exp. Sta.)

owner should carefully study the characteristics of each cow so as to find the limits of a cow's ability to convert feeds into dairy products profitably. It is with the cow as it is

with almost any other machine. A threshing machine has a limit to its ability. It is of no use to keep the threshing machine running at full speed without feeding it what it will properly handle. On the other hand, one must be careful not to overfeed it.

Good management.—The production of the present dairy herd may be materially increased by proper management and greatly decreased by improper management.

It is important that dairy cows freshen regularly, and that the proper time is allowed for each lactation period. A cow should freshen regularly each year. The length of time may vary some according to the individual cow. A cow probably should not be mated till about two or three months after freshening. No one can have a cow freshen exactly once each year, but on an average, throughout a cow's life, one calf each year gives the best results.

It is usually considered economical to give about six weeks' rest previous to freshening. While a cow during these six weeks is not producing any profit, it is generally considered that she will develop a stronger calf, that she will accumulate considerable strength, and store up a dynamic force for milk production to repay amply for letting her be dry that length of time.

Fall freshening.—The annual production of a dairy cow may be improved by having her freshen in the fall instead of in the spring. This is in no way due to the cow, but is due to seasonal conditions and surroundings that exist in most parts of the United States. According to the author's investigations, under the average farm conditions, the average dairy cow will produce about 20 percent more milk and butter fat when freshening in the fall than she will when freshening in the spring. Some cows will increase the production by fall freshening considerably more than this.

Most cows are kept in pasture during the summer, and most cows on the average dairy farm freshen during the spring. During the early spring months, when the cow is

fresh, the pastures as a rule contain plenty of feed, and cows will give the maximum flow of milk. Later pastures dry up, and heat and mosquitoes and flies make the cows uncomfortable. As a consequence, the milk flow from the dairy cow freshening in the spring gradually decreases. Such a cow goes dry early, or gives very little milk when fall or winter conditions begin.

A cow that freshens in the fall will yield a normal'y good flow of milk under winter conditions. When spring comes and the cow is turned on grass, the flow of milk is materially increased.

It will thus be seen that fall freshening lengthens the lactation period and causes a uniformly large flow of milk throughout a greater period than if the cow freshened in the spring.

Second, better labor at less wage may be had during the winter months. Raising the crops during the summer and having the cows convert these crops into dairy and animal products during the winter enables the farmer to keep his help busy throughout the year and to make the farm a factory for producing new wealth the full year.

Third, the price of dairy products is usually considerably higher during the winter months. The farmer should aim to produce the greatest bulk when prices are the highest. Usually butter fat is one-third higher during the winter months.

Fourth, the calves dropped in the fall are easier to raise than are those born in the spring. Fall calves do well under proper winter feed and care. When spring comes, they are from six to eight months old and may then be weaned and turned to pasture with the other young stock. Calves dropped in the spring need to be kept in or near the barn during the summer. During this time it is more difficult to keep the milk of uniform quality and the heat and flies are likely to bother the young calves considerably.

Improvement of Future Dairy Herd

There are two methods by which the future dairy herd may be improved in production. One is to buy good cows, and the other is to raise them. Which one of these methods is followed, or whether a combination of these two methods is followed, depends somewhat on conditions, and whether a person wishes to grow into the business.

Buy good cows.—If a person wishes to go into the dairy business quicker than he can by raising a herd, the buying of good dairy cows is probably the only way to start.

This method involves considerable capital. The owner of a good dairy cow is loath to sell her unless he receives an unusually high price for her. However, good cows are occasionally offered for sale at a reasonable price, and the alert dairyman, especially if he is a good judge of cows, can usually pick up a few profitable dairy cows in almost any neighborhood, especially if he lives in a community where dairying has been practiced for some time. A good grade dairy cow considered to be a profitable producer is now selling at a price of about \$100.

It can readily be seen that this method is applicable to only a few. There would not be enough good cows to go around, if all farmers should wish to practice this method of improving the dairy herds.

One point on which every purchaser of dairy cows should be careful is the danger of buying animals having some contagious disease. Tuberculosis, abortion, skin diseases, and other diseases of more or less significance, may be easily brought into his otherwise healthy herd. It is true that a buyer can purchase subject to inspection, but even then he may import animals with contagious diseases. Diseases may be present in an incipient or beginning stage and in a latent condition. If one resorts to buying dairy cows, he should be careful to obtain good cows, and not buy dairy cows just because they are colored like cattle belonging to some of the leading dairy breeds.

The author has known instances where there has been considerable sentiment for the purchase of dairy cattle. Some local stock buyer or local speculator goes east into the dairy districts and picks up culls of dairy-bred animals. In some instances, they are taken out of the stockyards of smaller towns in the dairy districts. Such animals can usually be bought cheap. While they may be colored like dairy cattle, they are generally poor producers.

At times representatives of a certain group of purchasers have been sent into dairy districts. These men may or may not know what constitutes a good dairy cow. They are men who probably have never had anything to do with dairy animals. They are good, substantial, reliable men, but outside of that, they know little about the dairy business. Such men are not likely to get the best dairy cow value for the money invested.

Again, dairy cows are selected by capable, disinterested men such as the local county agricultural agent. Such a person knows the different herds in a particular community. He is probably a man who has had considerable training in the judging of cows. Such a man is, or should be, capable of selecting the best dairy cows in a community, whether it be locally, or away from home.

As a rule, it is not a good plan to buy full aged cows. Few dairymen will sell a distinctly good cow in her prime of life. The purchase of good young cows or heifers, properly bred and reared, at a reasonable price, is a good investment.

Using a good dairy sire.—Every good producing family of cows owes its good dairy characteristics to two things: first, to heredity, and secondly, to good feed and care. Both factors are important, but since it is impossible with the best of feed and care to make an ordinary cow without dairy inheritance a large producing animal, it is evident that the right blood is even of greater importance than is the care and feed. There must be a natural predisposition in the animal to convert feed economically into milk and

butter fat. A cow is a vehicle for carrying the combined characteristics of the ancestors, be they good or bad, desirable or undesirable. What is not in the ancestors of the individual cannot come out in the descendants. True it is that occasionally there are individual large producing cows coming from ancestors not noted for their large production. This is due to the law of natural variation. Such cases are exceptions and not the rule. The dairy farmer who desires large and profitable producing cows cannot afford to follow

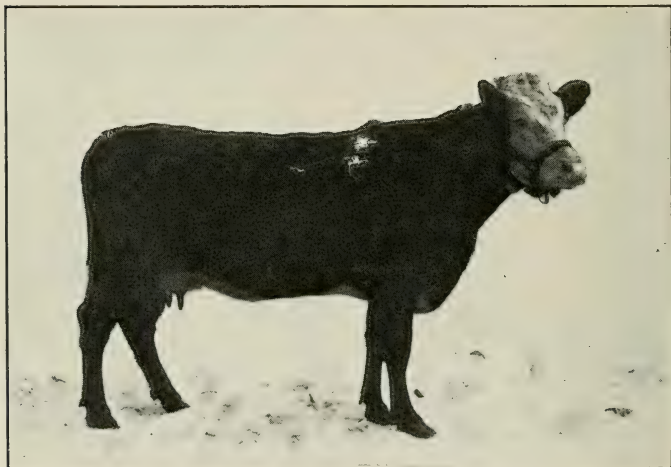


FIG. 46—Scrub dam "Laura." Record 3427 lbs. milk and 147.4 lbs. fat in 259 days. Weight 1329 lbs. (So. Dak. Exp. Sta.)

a method which is not reasonably sure to increase the production of his future dairy herd.

The statement has often been made that the sire is half of the herd. This applies especially when the future herd is kept in mind. For the present herd, the one great function of the sire is to cause the cows to freshen. For the future herd, his duty is to improve the offspring in type and production and to unify the type.

Considering that the sire is pure-bred, of good type, and

that he comes from a long line of high-producing ancestors, he should have more than half of the effect on the offspring. The common grade cows offer but little resistance to improvement by the use of a pure-bred dairy sire.

It is now well known that the milking qualities of the female are hereditary, even as much as is the color. It is

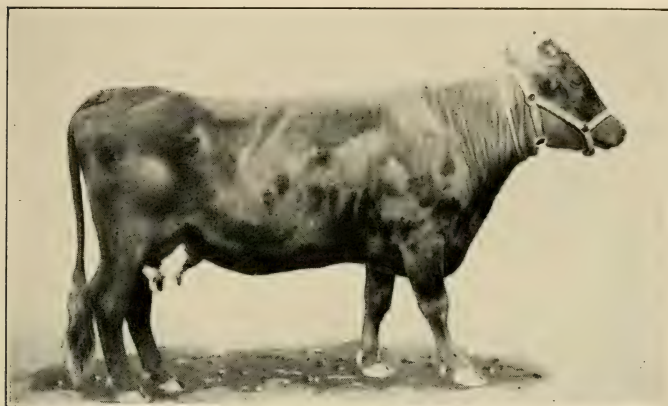
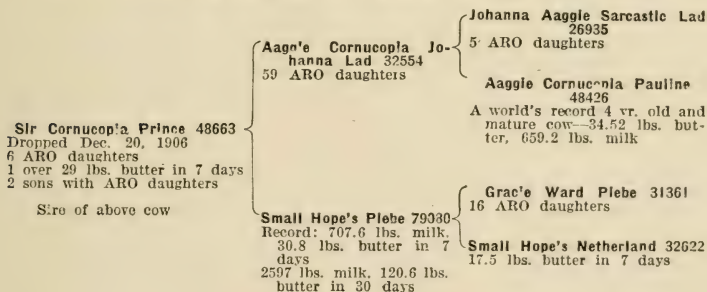


FIG. 47—Holstein daughter of "Laura." Record 6241 lbs. milk and 230 lbs. fat in 291 days. Weight 1380 lbs.



also well known that the ability to produce milk and butter fat can be transmitted through the male as well as through the female. According to data given by Dean Davenport of Illinois, the sire is even stronger than is the dam to

transmit the milk production to the female offspring. This is probably accounted for by the fact that the male is usually better and more carefully selected as to the right blood or as to dairy inheritance.

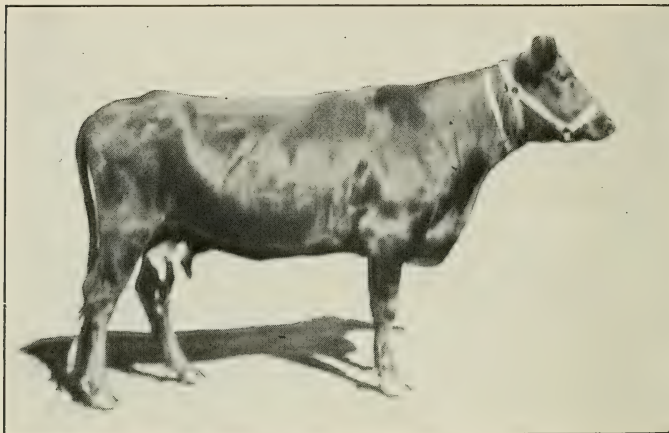
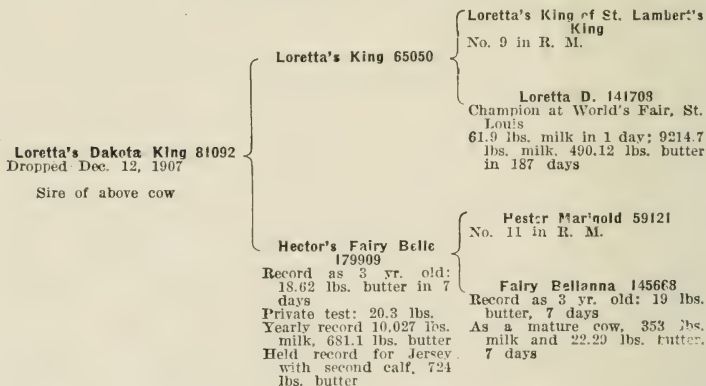


FIG. 48—Jersey daughter of "Laura." Record 3947 lbs. milk, 178 lbs. fat in 305 days. Weight 1090 lbs.



The chief functions of a dairy sire may be summarized as follows:

1. To cause cows to freshen. It is well known that freshening causes a cow to renew her flow of milk. Maternity is the chief cause of milk formation. In the past, many sires have been kept for this one purpose alone.

2. To perpetuate its kind without regard to quality. Some people in the past have thought that a cow is a cow, and that a calf is a calf. Very little weight has been given to the kind of a sire, thinking that one sire will cause a cow to conceive just as well as any other one.

3. To improve the production of the offspring. This applies to the male calves as well as to the greater amount of milk and butter fat obtained from the female offspring.



FIG. 49—A well-selected dairy sire for such a dairy herd will prove of great value.

4. To improve and unify the type, size and markings. There is no reason why beauty and utility cannot be combined. There is no reason why the individuals in the herd cannot be of uniform size, or cannot be of the same color. Such a herd imparts evidence of having been intelligently produced. Such a herd appears well to the stranger, who may be a buyer. When it comes to the selling of such a herd, the demand will be great and the price will be correspondingly high.

The improvement of the herd by the elimination of

impure blood, from the standpoint of breeding and by continuing with a pure-bred sire belonging to a certain breed, is fundamental to increased production.

From the standpoint of production and from the standpoint of appearance, the females having four or more crosses of pure-bred blood are as good as is a pure-bred registered cow. Except in a few of the new cattle organizations, a high grade cannot be registered.

Value of a good dairy sire.—It is difficult to calculate the value of a good dairy sire as compared with that of a poor one. The following method, proposed by Prof. Fraser of Illinois, may serve to show that a good prepotent dairy sire is a good investment for the dairyman, even though the initial cost seems a little high.

	Scrub sire	Pure-bred sire
Initial cost of sire.....	\$ 25	\$125
Interest at 8%, 3 years.....	6	30
Cost of keeping 3 years at \$40.....	120	120
Total expense for 3 years.....	\$151	\$275
Estimated value at end of 3 years.....	54	54

Total cost of providing sire for three crops of calves \$97 \$221

Granting that the average herd numbers 20 cows, there would be 60 calves during three years. The cost of providing a scrub sire for 60 calves would be \$1.62 ($\$97 \div 60$).

The cost of providing a good pure-bred dairy sire for each calf is \$3.68 ($\$221 \div 60$).

Thus far, the cost of providing a pure-bred sire for each calf is \$2.05 greater than the cost of providing a common grade sire for each calf. The maxim that "Some hold the penny so close to the eye that the dollar cannot be seen in the distance," applies here. The economy of providing a good dairy sire is not realized until the female calves freshen. The male calves can easily be disposed of at a good price. So it is not considered advisable to limit the cost of providing a good sire to the females alone.

If a pure-bred sire has been properly selected, he should increase the production of the heifer-offspring over that of

the dam by not less than 20 percent. In some instances, experimental data shows that the sire may increase the production of the heifer-offspring over that of the dam's by 100 percent. As the herd is graded up, it is evident that the percentage of increase in production decreases. The poorer, or less the production of the dam, the greater will be the percentage of increase in production of the female offspring. This does not mean that one should select poor producing cows with which to mate the pure-bred sire. When stated in percent, however, a greater relative increased production is usually obtained from low-producing cows.

Paternal ancestors.—There seems to be no definite knowledge as to which one of the parents is the most prepotent in the transmission of the dairy characteristics. This depends more on the individual inbred characteristics than it does on sex. Generally speaking, the individual representing the largest production of the female ancestors, and dairy prepotency of male ancestors, is the most powerful in the transmission of dairy characteristics. From these standpoints, pure-bred dairy sires have been better selected than cows. It is, therefore, reasonable to assume that the males are of greatest importance. Considering the great influence of the sire upon both the production and type of the future herd, great care should be exercised in the selection of the herd bull.

A tried dairy sire that is known to have sired uniformly large producing cows is very desirable. Many times an aged herd bull is discarded too early.

In most instances the herd bull is selected while young. It is in this connection that it is important to select ancestors, especially near ancestors of large production and of good type.

The dairy prepotency of the bull, undoubtedly, not only depends on the productiveness of the ancestors, but also on the skill with which the blood has been combined, whether the individual has been inbred or line-bred, or whether



FIG. 50—The value of a good dairy cow and a good dairy sire is explained on a South Dakota dairy train.

there have been continuous indiscriminate out-crosses in the pedigree. Theoretically, the closer an individual is inbred, the more prepotent he is. This prepotency is manifested in transmitting poor qualities as well as good qualities. Inbreeding fixes both good and bad characteristics. For this reason, inbreeding is dangerous to the inexperienced breeder. To the skillful and judicious breeder, inbreeding is a valuable aid to attain certain characteristics in the offspring.

In the summer of 1908 the author began a breeding experiment with six common grade cows. These six cows were mixtures of Shorthorn, Hereford and unknown scrub. One probably had some Red Polled blood in her. She was a natural muley. The original plan was to mate these six cows to a pure-bred Holstein sire for three successive years, and retain all of the female offspring, and follow this up with Holstein blood by mating all of these and the other female descendants to a Holstein sire.

During the succeeding three years, the plan was to mate these same cows to a pure-bred Jersey sire and save the female offspring, and mate them and their descendants to pure-bred Jersey sires.

During the third three-year period these same original scrub cows were to be mated to a pure-bred Guernsey sire, the female offspring retained, and they and their descendants mated to a Guernsey bull.

During the fourth three-year period these same original scrub cows were to be mated to a pure-bred Ayrshire sire and the females and their descendants retained and mated to an Ayrshire bull. All records of production of dairy products and calves and consumption of feeds were kept.

At the present writing, these experiments have been continued until 1919, or about 11 years.

Because several of the first calves dropped by both the first and second generations were males, this experiment is not so far along as it should have been. In fact, so many

male calves have been dropped by some cows that it was inadvisable to retain them.

Some very interesting results, however, have been obtained by the use of a Holstein sire, and also by the use of a Jersey sire. The following data shows the improvement of the daughters over the dams by mating these scrub cows to a pure-bred Holstein bull.

Name of cow	Number of days in milk	Lbs. milk	% fat	Lbs. fat
Daisy (Unimproved dam)	237	3209.6	4.23	135.79
Floss (Half Holstein daughter)	237	5895.4	3.79	223.23
Increase of daughter over dam	....	2685.8	....	87.44
Muley (Unimproved dam)	237	4090.7	4.28	175.05
Muley 2d (Half Holstein daughter)	237	6090.2	3.66	222.88
Increase of daughter over dam	....	1999.5	....	47.83

The above data has been calculated for each cow from an equal number of days. The grade cows had the shortest lactation period, not because they were bred earlier, but because of their natural inclination to go dry early.

If the above data had been calculated from the amount of milk produced in a given lactation period, the difference in the production of the dam and the daughter would be still greater. The lactation periods have been reduced to the length of the shortest one, which was that of Daisy.

Similar results have been obtained at other experiment stations. At the Iowa station (Bull. 165), the average results show that the first generation heifers from scrub cows by a pure-bred Holstein sire gave an increase of 2314.5 pounds, or 71 percent in milk, and 67.15 pounds, or 42 percent increase in fat.

The first generation of the Jersey grades showed an increase of 205.6 pounds, or six percent more milk, and 32.9 pounds, or 20 percent more fat. The average age of these Jersey grade heifers was $2\frac{1}{2}$ years. The average age of the Holstein heifers above mentioned was $3\frac{1}{2}$ years.

One Guernsey grade heifer improved the milk production over that of the dam by 3451 pounds, or 131 percent of

the milk, and 179.22 pounds of fat, or 136 percent. The average age of this heifer was three years. The average records of the other three Guernsey grades were not quite equal to those of their dams.

At the Ohio station (Cir. No. 135) one Holstein-Friesian bull increased the average production of his seven daughters 1299 pounds of milk and 40 pounds of butter fat per year above that of the dams. In this same bulletin it is also reported that one

Jersey sire decreased the average production of his 11 daughters over 700 pounds of milk and over 45 pounds of butter fat per year under that of the dams. This particular instance is a good example of the great im-

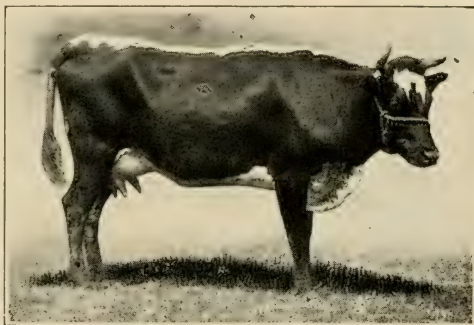


FIG. 51—Scrub cow No. 56. Av. production 3874.6 lbs. milk, 1927 lbs. fat. (Ia. Exp. Sta.)

portance of using care in selecting a pure-bred herd sire. It is not all pure-bred animals that will increase the production of the herd, nor can it be said that one breed is stronger in this respect than another. The success of grading up a common herd of cows lies in the selection of a prepotent sire of strong individuality, and steeped in milk and butter fat heredity.

Inbreeding.—The extent to which inbreeding, that is, mating of close relatives, should be followed cannot well be told by anyone unless the animals in question are known. Nearly all successful breeders have practiced inbreeding more or less. Too close inbreeding cannot be generally recommended; yet, in some instances, it brings the very best of results.

Too much inbreeding may lessen prolificacy. It may weaken the constitution of the offspring. It may affect the nervous energy. It may dwarf the size, and it may produce abnormalities in the offspring. All of these things the author has seen result from close inbreeding.

On the other hand, if the owner desires to stamp and retain certain characteristics in his herd there is no surer way of doing it than to practice inbreeding. Inbreeding makes inheritance of characteristics more certain. The breeder should remember that undesirable as well as desirable characteristics are fixed by inbreeding.

The author believes that line breeding should be practiced in every herd, providing the breeder is sure that the type

and production are what he should seek to develop in his herd.



FIG. 52—Half blood Holstein cow No. 77. Out of scrub cow No. 56. Av. production 6955 lbs. milk, 266.25 lbs. fat.

Keep bull separate from herd.—It is important that the service bull be kept in good condition; otherwise strong and healthy calves cannot be

expected. Many times the herd bull is permitted to run with the herd, even from the time he is young.

A herd bull running with the herd is exposed to too heavy service. If the bull is kept up, this can be regulated. One good service is just as good and even better than several, and it is not so exhausting to the sire. This is of special importance during the years when he is growing.

If the herd sire runs with the herd, it is difficult for the owner to keep track of the service date. This is especially

true with the heifers or the young stock that do not come up to the barn regularly to be milked.

When the herd bull runs with the herd, the bull himself is exposed to danger. He may crawl through the fences into the neighbor's herd. This may injure him. Besides, he may cause inconvenience and trouble by teaching other animals in the pasture to break through the fence. This may also be an imposition on the neighbors.

When the herd bull runs with the herd he is also more dangerous. It is true that some herd bulls are very gentle, but any bull is likely to become cross when some of the cows are in heat.

The safest and best way is to keep the bull in an enclosure and under control.

Care should be taken, however, to exercise the bull and to give him good care. It is wrong to put the bull into a small box stall in some rear part of the barn and give him little attention.

The herd bull should be the pride of the herd. The manner in which he is kept is often indicative of how the rest of the herd is handled and cared for.

There are various forms of bull pens. In some instances, there is a small open yard in connection with the box stall. The door between the open yard and the box stall may be closed and opened at will. This is a good way of keeping the herd bull.

The author has always kept the bulls in separate box stalls. A door leads from the box stall into the pasture. This pasture is long and narrow, rather than square. A heavy, high woven wire fence encloses this pasture.

Two or more bulls are usually let out together. Such a pasture provides good exercise and also good pasturage during the pasture season. During the winter it gives them plenty of room for exercise.

This method of keeping the bulls probably could not be used if they were exceedingly cross. No bulls of any breed are allowed to retain their horns in the herd supervised by

the author. This dehorning of dairy bulls is not approved by all dairymen, however. Some maintain that it lessens their dairy prepotency.

Some keep bulls in a box stall and lead them out for exercise daily. In some instances, a sweep is made. The bull is tied to one end of the horizontal pole. This is one of the best ways of exercising a bull that has to be tied.

Another way is to have a strong wire strung from one post to another. The bull is then tied to a heavy ring that slides from one end of this horizontal wire to the other.

Some use a tread power. Besides giving the bull exercise, this method furnishes cheap power.

The method of giving a bull exercise varies according to the bull and according to conditions on the farm. It is important, however, that the herd bull should not be allowed to stand tied up inside of a barn any length of time. Such a bull is not, as a rule, an active and sure breeder. He is not handled much and he may become cross.

The box stall should be substantially boarded on the sides to a height of about 5 feet. On the top of this, there should be a heavy iron net frame. This permits the bull to look out. A bull entirely shut off from the rest of the barn is likely to be uneasy. Some have perpendicular iron bars about 4 inches apart around the sides of the whole stall. If a bull has horns, he is likely to put them in between the bars and break the ends of the horns off. This is the only objection to such a stall. A stall having iron bars on all sides admits the best circulation of the air and it permits the bull to have a free view.

Bulls that are inclined to grow fleshy and sluggish, and do not exercise much of their own accord, should be forced to take a reasonable amount of exercise. Some do this by working them on the tread power. Others teach them to work in the harness, and others lead them around a little every day.

Handling a cross bull.—Many times a vicious bull has the very best of breeding and is strongly prepotent. It

therefore pays to retain and care for such a bull, even though some extra care is necessary. The owner of such a bull should not take any chances of being injured by him.

There are very few bulls that will willfully injure the regular attendant. A bull soon learns to know his master and caretaker. Some caretakers handle bulls in a way that brings out the worst there is in them, while others are kind, yet firm. Such a caretaker as the latter is usually safe with a bull. However, it does not pay to take any risk. The caretaker should watch a bull closely, and never allow him to get the advantage.

Some cross bulls are quieted by blindfolding them.

A cross bull often does not permit anyone to catch his ring. A man with a long hook can usually get hold of the ring from the sides of the box stall. If he cannot, then it may be necessary to keep the bull tied all the time.

It is not advisable to tie the bull in the ring alone. He may break the ring, elongate the nose, or pull the nose out entirely. A cross bull with the muscle of the nose pulled out is very difficult to handle.

A heavy halter, or a strong neck strap, should be used for tying, in addition to the ring. The halter rope should be tied shorter than is the rope in the ring. Some keep the bulls tied by using a heavy strap around the neck. Some tie them to a heavy perpendicular post placed in the center of the box stall, the top fastened to the ceiling and the bottom set in the ground. The ropes or chains are fastened to a ring sliding up and down the post.

A herd bull in heavy service should be fed grain. A ration composed of six parts of oats, two parts of barley or speltz, two parts of bran, one part of oil meal, together with good upland wild hay, makes a good ration. In case alfalfa hay is used for roughage, two parts of corn may be added to the above-mentioned ration, or the barley increased to three parts instead of one part. All of the grain should be ground.

The author has not had much success in feeding silage to the bulls in heavy service. In every instance they have become sluggish and very slow for service. There are some, however, who recommend giving bulls silage.

Do not change breeds.—To change breeds every now and then is a poor practice. A number of dairy farmers are of the opinion that if two different breeds are crossed, the progeny will inherit only the good qualities from each.

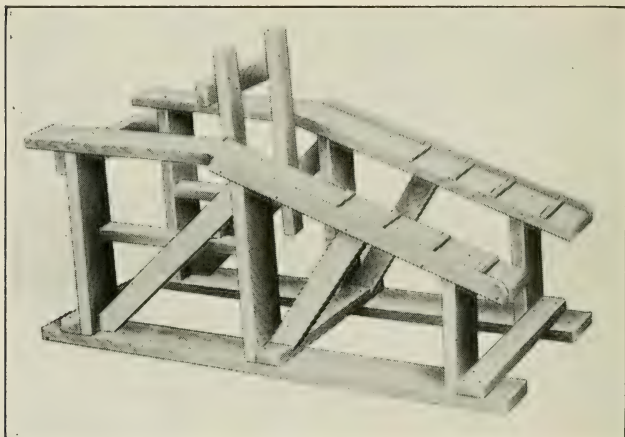


FIG. 53—Breeding crate. This crate is made entirely of 2 x 4 and 2 x 12 pieces. The bottom pieces are 9 feet long; the width between planks is 2 feet; the height at the front is 20 to 24 inches; the length from rear to center post is $4\frac{1}{2}$ feet; and the height of the center post should be from 3 to $3\frac{1}{2}$ feet. (Courtesy of Ohio Exp. Sta.)

For instance, if Jerseys and Holsteins are crossed, some people think the offspring will produce the large flow of milk usually given by the Holsteins and the richness usually given by the Jersey cow. Such a result may follow. Usually, however, when two different breeds are crossed, the offspring represents about an average of the two. The succeeding generations, however, are more indefinite. The blood line has been broken, and there will be little unity and definiteness in the type and little utility in the offspring.

The author refers now especially to grades on one side and a pure-bred sire on the other.

It is not an uncommon thing for the dairy farmer to use a Holstein sire for two or three years in order to obtain a large flow of milk and size in the herd. At the end of this period, he may change his mind and use a Guernsey in order to obtain richer and more yellow milk. Perhaps he will change his mind again and purchase a pure-bred Ayrshire sire in order to introduce rustling qualities in the offspring. It is such changes that are not desirable.

Great care should be taken to get good type, and individuals that are good producers and that belong to a good producing family or strain. If a pure-bred sire of such characteristics is obtained, there is little occasion to change breeds. It means that he should use greater care in selecting the right strain and type.

Bull association.—The cost of a good pure-bred sire coming from large producing ancestors is one of the drawbacks and objections that hinder many farmers from improving and unifying their dairy herds. Some pay from \$100 to \$500 for a dairy herd sire. Such a sire is used, as a rule, only about three years in one herd unless the herd is large enough for using two sires.

To obviate this expense of purchasing a herd header every three years, breed associations have been formed.

A breed association consists of a number of farmers who meet and mutually agree to purchase several pure-bred dairy sires of one particular breed. Usually the number of sires purchased is three. It is the number of cows on which the breed association is based, rather than on the number of farmers.

In Michigan, Wisconsin and other states, community breeding has been practiced considerably. Community co-operation of this kind is made up of breeding circuits. A breeding circuit may be formed from three different units, each unit containing the number of cows which one bull can serve. This number may be from 30 to 60 cows. If

half of the herd is mated one part of the season and the other half another, a bull can serve even more than this number. Several farmers may own these 40 cows and that one bull, or one farmer may own them himself. There are instances where one farmer has a herd of only about 15 cows and is willing to buy a bull for his own use rather than to co-operate with the neighbors. There may be three units of, say, 50 cows each. A bull is provided for each of these separate units in the circuit. At the end of the first three years the bulls are exchanged again. At the end of these nine years the bulls have gone the complete circuit.

	Bull A	Bull B	Bull C
First three years-----	40 cows	40 cows	40 cows
	Bull C	Bull A	Bull B
Second three years-----	40 cows	40 cows	40 cows
	Bull B	Bull C	Bull A
Third three years-----	40 cows	40 cows	40 cows

The above illustration shows how this change occurs. This method of community breeding not only obviates the buying of a new bull each three years, but it gives the farmers belonging to the circuit an opportunity to see what kind of heifers each one of these bulls will sire. Many times good bulls have been disposed of too early.

This method of improving the dairy herds is economical, and it is very practicable. It is basic to the improvement of the dairy industry. It is a plan which deserves much greater use than is practiced at present.

Value of pedigree.—Too much emphasis may be placed on the pedigree. An animal should not be selected from the pedigree alone. The form, size and poise of the animal must be emphasized also.

The value of a pedigree may be said to depend on several things. It depends, first, upon the honesty of the breeder and of the employees, and upon the system and correctness with which the records of the individuals in the herd are kept. Though rules regarding registration and performance of cows in the herd are very strict, a

dishonest breeder and a dishonest employee may evade at least some of them. Besides, carelessness and lack of correct record keeping may cause mistakes.

Statement showing Growth of Co-operative Bull Associations in the United States to July 1, 1916. (Dairy Division, U. S. Dept. Agri.)

State	1908	1909	1910	1911	1912	1913	1914	1915	1916	
Michigan	1	4	7	6	10	15	15	14	14	
Minnesota		1	1	1	1	2	2	2	3	
North Dakota					1	2	1	1	1	
Maryland					1	1	1	1	1	
Vermont							1	1	1	
Wisconsin							1	1	1	
Connecticut								1	1	
Maine								1	1	
Oregon									1	
Oklahoma									1	
Iowa									1	
South Carolina									3	
Massachusetts									1	
North Carolina									1	
Illinois									1	
Total	1	5	8	7	13	20	21	22	22	

Second, it depends upon the qualities of the ancestors, especially the near ancestors. This refers to uniformity of good type or form, to uniformity of large economic production of females, and ability of males to sire numerous offspring of uniformly good type and production.

The value of a pedigree depends, thirdly, upon the manner in which excellence has been combined in the pedigree. Numerous outcrosses of blood foreign to the dominant type and strain do not add strength to a pedigree.

Fourth, it depends upon the healthfulness and longevity of the various animals in the pedigree.

There are two kinds of pedigrees in use: The tabulated and the extended. The tabulated is used nearly altogether by the dairy cattle breeding associations. It gives equal weight to each animal in the pedigree. The extended pedigree gives names of only the dams on the mother's side. The names of all of these females are given, back to the imported cow.

The following illustrates the tabulated form of pedigree:

Sex				
		Sire	{ Paternal grand sire { Paternal great grandsire { Paternal grand dam { Paternal great grand dam	
Name and number of individual				
Date dropped.....				
Color.....				
Summary of ancestors				
.....				
Name and address of breeder				
		Dam	{ Maternal grand sire { Maternal great grand sire { Maternal grand dam { Maternal great grand dam	

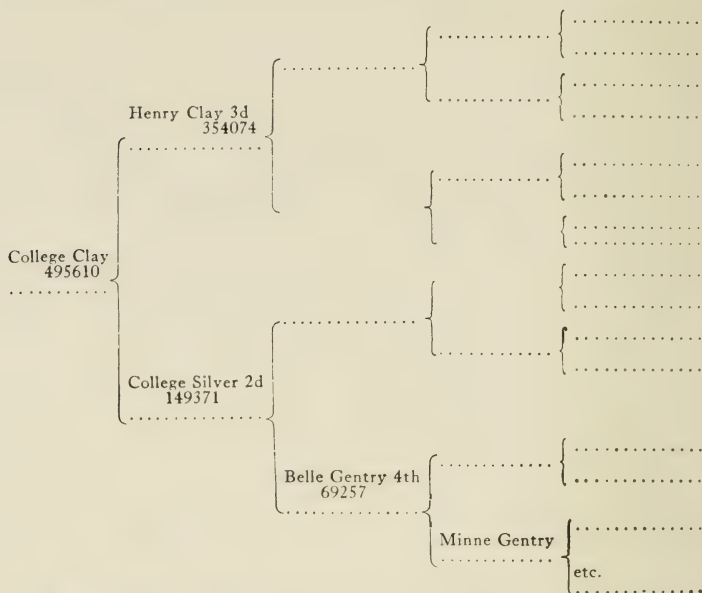
The defects in the extended pedigree shown on following page are apparent. There is no room for stating milk and butter fat performances nor achievements in the show ring. In addition, this pedigree mentions only the dams on the mother's side.

The American Shorthorn Breeders' Association uses this form of pedigree. It is combined with the registration certificate. Formerly only the males were numbered. In recent years the females have also been numbered. This enables a person, by the aid of the herd books, to make out a tabulated pedigree with greater ease.

The following illustrates the extended form of pedigree

Name and number....College Clay 495610.....Sex.....Female.....				
Description.....Date Dropped.....				
Breeder.....Owner.....				
Dams	Breeders of Dams	Sires	Breeders of Sires	
College Silver 2d 149371...	So. Dak. St. College.	Henry Clay 3d.....	C. A. Otis.....	354074
Belle Gentry 4th.....	So. Dak. St. College.	Henry Clay 3d.....	C. A. Otis.....	354074
Belle Gentry.....	So. Dak. St. College.	Victor of Brookings.	C. E. Hancock.....	224328
Minnie Gentry.....	So. Dak. St. College.	Summit.....	H. E. Harris.....	177977
Ada Belle Major.....	J. P. Steele.....	Cleopatra's Major.....	J. P. Steele.....	91019
Ada Belle 2d.....	J. H. Foster.....	Earl of Dardenne.....	T. E. Talbott.....	23021
Savanna 2d.....	J. H. Foster.....	Excelsior.....	J. M. Glover.....	14214
Savanna.....	R. Scott.....	2d Dk. of Stoner.....	G. M. Bedford.....	6692
Peach.....	The Shakers.....	Lawrence.....	R. A. Alexander.....	3064
Louisiana.....	The Shakers.....	Logan.....	The Shakers.....	1783
Tracing to.....	The Shakers.....	Pioneer.....	The Shakers.....	820
IMP Mrs. Motte.....		Adam (717).....		

If the preceding extended pedigree were tabulated it would appear as follows:—



Maternal ancestors.—The above discussion in this chapter refers chiefly to the importance of selecting a pure-bred and prepotent sire. It is equally important to provide good producing and good typed maternal ancestors, although it is widely believed that the sire's prepotency is the stronger, yet no one knows absolutely which one of the parents is the more prepotent in the transmission of the dairy characteristics. Generally speaking, the individual that is of purest blood and that represents the largest amount of large producing blood in the near ancestors is the most powerful in the transmission of dairy characteristics. Results of experiments clearly demonstrate that it is important that the maternal dam and dam's near ancestors should also be good individuals as to both type and production.

One unimproved cow in the South Dakota state college dairy herd produced 175 pounds of butter fat in one year. The daughter produced 310 pounds. Another unimproved cow produced 152 pounds of butter fat in one year and her daughter produced 232 pounds. Other results indicate that the greater the production of the dam, the surer and greater will be the production of the offspring.

With this view, heifer calves from the best producing cows should be saved and used as members of the herd. In many instances the members of the average herd are not large producing cows. Every farmer, however, has some cows that are better than others. Some farmers have

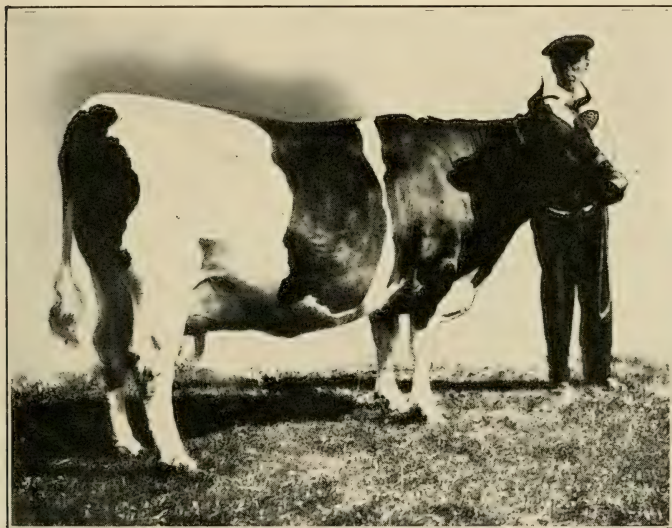


FIG. 54—A cow that has been prepared for an advanced registry test. She has been dry for several months, and heavily fed to get her in good flesh.

in the herd several individuals of one family. Perhaps it is mother, daughter and granddaughter that are better producers than any of the remainder of the herd. Efforts should be made to raise the heifer calves of such a family of cows.

It is evident that in the average grade dairy herd it is difficult to trace the producing ability of the maternal ancestors for several generations. Records have not always been kept, and the ownership frequently changes, so that the selection on the maternal side must often be made from the knowledge of only one generation. If no heifer calf is selected to be a member of the future herd without first applying the rule that the dam must be a large producing cow, one big step has been taken towards building up a profitable dairy herd.

In the breeding and raising of pure-bred dairy cattle, the rules should be made to read that dams in the first three generations must be large producers. Pure-bred registered cattle have a known pedigree. The owners of the animals are also known, and in many instances the in-



FIG. 54½—A herd of unimproved cows used for dairy purposes in a new country.

dividuals are in the advanced registry. From these sources, knowledge of the producing ability of the near ancestors can be ascertained.

In examining the records of cows, the amount of milk and butter fat produced and the circumstances under which the records were made should be examined and carefully considered. Especially is this important if the production represents short-time tests. Experiments, as well as practical results, have amply demonstrated the fact

that the percent of fat in milk for short periods can be increased beyond normal. If a seven-day official test record of a Holstein cow, for instance, shows 350 pounds of milk containing 21 pounds of butter fat, this should be regarded as an abnormal test. The milk in this instance contained six percent of fat, which is not normal to this particular breed of cattle, whereas a production of 600 pounds of milk and 21 pounds of butter fat would represent a normal richness of milk for this breed. The latter cow, if of good form, would be a much more desirable cow to select as a foundation cow than would the first mentioned. In examining the records of cows from any of the breeds, one should examine, in so far as possible, with the view of finding out whether the production was made with normal feed and the cow in normal condition.

CHAPTER VII

RAISING THE DAIRY COW

There is no subject so important to the dairy farmer as is the proper raising of the dairy cow. Upon this depends, to a large extent, the profitableness of the future herd. The important steps in the raising of the future dairy cow are fundamental in character.

These steps are chiefly three:

1. Selecting the right parents.
2. Caring for mother during pre-natal period.
3. Caring for calf after birth, or during the post-natal period till first freshening.

Selecting Right Parents

Every calf has a right to be well born. Probably the best way to accomplish this is to see that the right parents are selected. Both the male and the female parents must be healthy. The life germ must be active and in every way normal.

The importance and the manner of selecting the parents of a calf have been discussed in the previous chapter.

Feed and Care During Pre-Natal Period

Relatively little is known about the external factors which affect the growth of the calf during the pre-natal period. The gestation period, or the period during which the cow carries the calf, is about 275 days. The length of this period varies a little. Usually a young, healthy cow requires the least time for developing a calf. An aged cow usually carries her calf a few days over time. A male calf is usually carried a few days longer than is a female calf.

In some cases there is an inclination for the dairy farmer to think that if a cow does not milk she ought not

to be fed. This is especially true in the section where dairy farming is carried on only as a side line. The dry cows, or the cows carrying their calves, are at times turned out to "rustle" their own feed in the cornstalk field, and on the meadows, and to secure all the additional roughage they need from the straw pile. The author has personally seen dry cows receiving no shelter at all except an old straw pile during very cold winter weather. If such cows are to freshen in the spring, they come out of the winter in a very poor physical condition. In some instances such cows are so weak after freshening that they are unable to stand on their feet.

While it may be helpful, from certain standpoints, for the animal to be out in the fresh air, this manner of procedure certainly is not conducive to the production of a strong, healthy calf.

A cow while carrying the calf should be fed a good and properly selected ration. It is usually considered that a mother should receive a ration medium rich in protein. A palatable feed balanced to about one part of protein to seven parts of carbohydrates gives good results. Someone has stated that "a bushel of corn given to a cow previous to freshening is worth two bushels after freshening." This statement is probably not true literally. It is, however, certain that a good healthy dairy cow will store up extra body flesh during the period that she is not in milk, and if she is the right sort of a dairy cow, this extra body flesh will be converted into milk after freshening.

A cow that is fed a ration rich in fat and heat producing substances and becomes very fleshy during the gestation period often drops a very small and weak calf. This extremely fleshy condition of a cow should be avoided.

Effect of surroundings of cow on calf.—It is very difficult to state definitely just what effects, if any, the surroundings of the pregnant cow have on the calf. It is generally believed that the nervous temperament of the calf and even the appearance may be affected during the

pre-natal period through the cow. The Bible states, Genesis 30-37, that Jacob was to receive all the speckled and streaked stock as his hire. In order to increase these in number, he peeled the bark off of sticks and put them into the watering troughs. It also states that he put these partially barked limbs into the watering troughs, when the best and strongest females came to drink. This method, the Bible states, resulted in Jacob becoming the owner, first, of many cattle, and, secondly, of the strongest and best stock.

The author knows an intelligent and judicious dairyman who believes that in order to develop a good dairy heifer it is important that the cow, during the gestation period, come into the barn, and that she have the opportunity of seeing the milking utensils and of seeing the other cows milked. He believes that such surroundings will have a favorable effect upon the dairy qualities of the calf not yet born.

The surroundings of the cow should be of such a nature that the cow is kept quiet. It is a well-known fact that an excited cow and a cow with a bad disposition usually gives birth to a calf of a similar nature. It is possible that this quality is not inherited from occasional excitement, and at the same time there can be no question as to the importance of keeping the mother in surroundings that tend to develop quietness rather than excitedness.

The extent to which feed, surroundings and disposition of the mother affect the calf during the pre-natal period, no one can say. It is, however, certain that nothing harmful can come from providing the most favorable conditions in these respects for the mother during the gestation period, while decidedly unfavorable results may follow careless methods in caring for the cow during the calf's pre-natal period.

Feed and Care of Calf

Under some dairy farm conditions few or no calves are raised. In case the milk is sold at from 8 cents to 15 cents

per quart for direct consumption, it can readily be seen that as few calves as possible are raised on milk. Under such conditions only a very select few of the heifer calves are raised. In some instances the calves, male and female, are sold, or given away, as soon after birth as the mothers' milk can be sold, usually when about a week old.

In districts where market milk is produced and condensed milk, milk powder and cheese are made from the milk, relatively little importance is attached to the raising of calves. Usually so large a price is obtained for the milk that the dairy farmer considers that it does not pay to raise the calves, and that it is better for him to milk the cow as long as she will milk and then buy another to replace her when she goes dry.

It is true that there are substitutes for milk that can be used. However, nothing has been discovered that will produce such good, healthy-looking calves during the first week as will mother's milk. If calves are raised on one or more of the various kinds of substitutes, considerable trouble and attention are necessary, and for a time at least the calves will be more or less scrawny.

It can readily be seen that if very many dairy farmers would follow the policy of no calf raising, there would soon be a shortage of good dairy cows. In fact, this shortage is apparent now. This is evident by the high price paid for good young healthy and properly bred dairy cows, and the high price that is being paid for them as compared with their value a few years ago. Every dairy farmer, even though he sells his milk at a good price, should arrange to breed and raise at least enough heifers to replace the cows in his own herd. He is sure of better bred cows, better individuals, and good healthy stock. If he purchases his cows, he runs considerable risk.

Care of calf when first born.—If the mother has been in good physical condition, and she freshens in a normal manner, the calf should be normal at time of birth. If the presentation of the calf is normal, little help need be

given. The normal delivery of a calf is front feet first and the nose and head resting between the two front legs. In case of a heifer, and with some cows, it is desirable and even necessary to assist in the delivery of the calf by gently pulling on the calf's front legs.

There is some difference in opinion as to whether a calf should be taken away from its mother at once after birth or whether it should be permitted to remain with its mother for some time. There are some who do not even put a cow into a stall by herself during freshening. She is left in the stanchion in the barn. Under such conditions the mother scarcely has a chance even to see the calf.

The author believes that every cow should have an opportunity, not only to see the calf, but to lick the calf. At times the calf is weak when first born. Such a calf benefits by being handled. The mother's licking is the best sort of handling. There are some who remove the calf at once, and in case of weakness will take a whisk of straw and thoroughly rub the calf. If the mother licks the calf, this rubbing is not necessary. Should a calf be so weak as to not breathe well, the attendant may gently open the mouth of the calf and blow into the calf's mouth. He may also take hold of the front legs and gently pull them apart and then let them come together again. At times this will aid the calf in respiration.

With a normal calf it is not necessary to do anything except to put it to its mother's head.

With normal freshening, it is not necessary to do anything with the navel of the calf. In case there is any danger of calf cholera or white scours, or in case the owner wishes to be sure to prevent it, he should paint the cord at the place of breaking with tincture of iodine, or disinfect it in a 2½ percent solution of carbolic acid. Under normal conditions, however, the navel will heal itself.

For some time the author used to turn the cows loose in a box stall before freshening. Now he puts a halter on the cow and ties her to the manger during the freshen-

ing time. At times a cow running loose in a box stall will lie down with the hind quarters up against the corner of the stall, or very close to the wall. This may interfere with giving the cow the proper help in case it is necessary, and it may interfere with proper delivery of the calf. If the cow is tied in the stall, one is always sure of plenty of room behind the cow.

The length of the time that the calf should remain with its mother varies with the different dairy farmers. It cannot be said that there is any definite time when the calf should be taken away. The author practices leaving the calf with its mother until the milk is in condition to be used. This length of time varies some according to the condition of the cow; usually it is about three days. During these first days a cow is not giving her full flow of milk. This first milk is essential for the calf, whether he is allowed to remain with his mother or whether he is fed from the pail.

With the ordinary unimproved cow, it is probably not necessary to milk the cow during these first few days. Few of the common cows give more milk than the calf will take. With the improved dairy cow, the herdsman should see that the cow is milked regularly, during the time that the calf is with the dam, as well as after the calf is taken from the dam.

In case the cow is troubled with a swollen udder it may be advisable to leave the calf with its mother a little while longer.

Some object to leaving the calf with its mother because she usually longs for the calf after it is taken away, and may even refuse to give down her milk for some time after the calf has been removed. This is especially so in case of a heifer. However, the author has never found any difficulty in this connection.

The leaving of the calf with its mother is consoling and comforting to the cow. She is feverish and needs

the calf for a few days. Besides, it gives the calf a good start in life.

The care of the cow during the freshening period will be considered under a separate head in connection with feeding the cow.

Place in which to keep calves.—It is important that the dairy farmers have a good place in which to keep the calves. By this the author does not mean that every dairy farmer should have an especially built calf barn artificially heated. Such comforts are often given to calves raised by breeders of pure-bred cattle. Calves raised under such conditions, of course, appear slick, and are well as long as they are in such surroundings. Calves raised under such conditions, however, will have a setback when finally they are sold and put into surroundings and conditions such as the average dairy farmer has.

There is, however, a general neglect on the part of the dairy farmer in providing a suitable place in which to keep calves. There is a tendency for the average farmer to put the calves into any part of the barn that is handy. The author has personally seen little calves put into a dark, unventilated small place cut out of the side of a haymow near the center of the barn. Such a place is unsanitary and unfit for calves.

The author has also seen little calves put into one large pen, even one having modern calf equipments, in one corner of the main barn in which all of the cows were kept. Every night this barn was very close and warm. During the time the cows were out and when the barn was being cleaned the temperature was very low.

Under such conditions calves are likely to take cold. The calf stalls should be separate from the remainder of the barn. Preferably they should be on the south side of the barn. There should be plenty of sunlight and good ventilation. The stall should be kept dry and well bedded.

There should be several small stalls rather than one large one. This prevents bunching and crowding during

feeding, it enables the attendant to keep the stalls and the calves dry and clean, and it enables the herdsman to separate the calves according to size and sex.

In front of the calf stalls there should be feeding mangers and stanchions. Under no circumstances should there be more calves in the pen than there are stanchions. When feeding time comes each calf should be fastened in the stanchion. He should remain there during feeding and a short time after feeding.

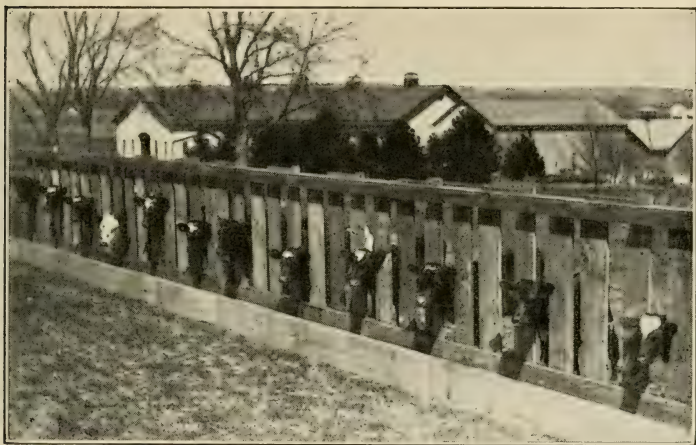


FIG. 55—Homemade stanchions for feeding calves in pasture.
(Courtesy Kansas Exp. Sta.)

If the calves are permitted to get loose at once after feeding, especially if there are a good many calves in one stall, there is a tendency for them to suck each other's ears, navels and scrotums. This should be prevented, and usually is, if the calves are allowed to remain in the stanchions 10 or 15 minutes after each feeding. It is a good plan to feed them fresh grain at once after feeding the milk.

Teach calf to eat grain early.—Every calf should be taught to eat grain as early as possible. This may be done

in several ways. A good way is to put the small calves together in one or two pens. There should not be more than six calves in one pen. A smaller number is better. Some keep individual pens, which, from the standpoint of the breeder, is the best. From the standpoint of the average dairy farmer, probably the keeping of three or four calves together is just as practicable. The smallest and youngest calves are first put together in one pen and the second largest size in another pen, the third largest size in still another one, and so on. When the calves reach a certain age, it is necessary to separate the male calves from the females.

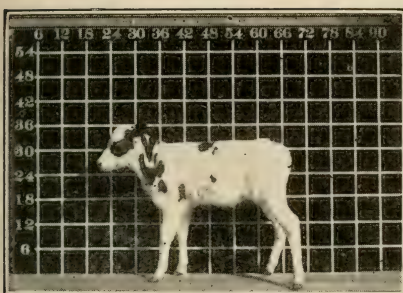
In the pen where the little calves are there should be one calf that knows how to eat grain. Little calves are imitators. When they see the older calves eating grain the little ones will often begin to eat when only a few days old.

Another way to teach a calf to eat grain is to hold a handful of feed up to his mouth immediately after he is through drinking milk. Some of this feed will adhere to his moist mouth. The calf instinctively licks the grain off, and in that way gets started to eat grain early.

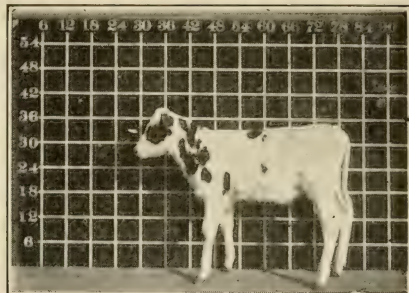
A calf should be used to eating grain when about two weeks old. Many calves will not eat more grain than they need until they are six months old. Ordinarily a calf will not eat more than three pounds of grain a day until after he is past six months of age. This is none too much for a calf of that age. When young a calf will not eat more than about one pound of grain a day.

Care should be taken not to spill milk in the manger. Care should also be taken that the grain is freshly supplied and that the manger is kept clean and fresh.

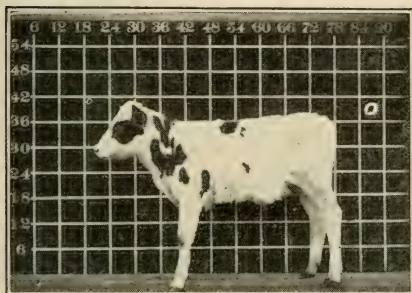
Amount of milk to feed.—Granting that the calf is permitted to remain with its mother for about three days, the feeding from pails begins at this point. The first day the calf will probably not drink more than about two



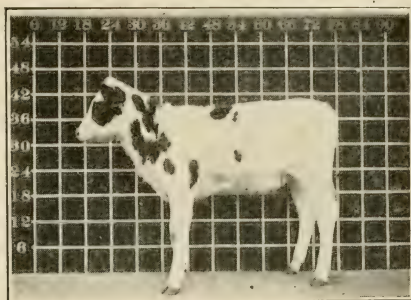
33 Days of Age



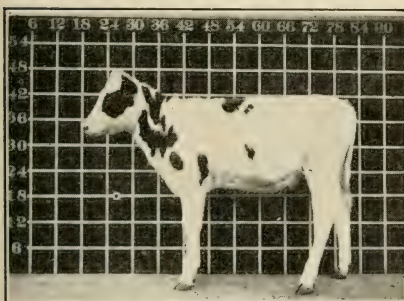
60 Days of Age



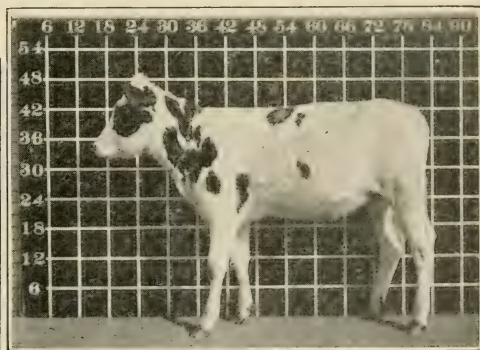
90 Days of Age



120 Days of Age



150 Days of Age



180 Days of Age

FIG. 56—Illustrating growth of a calf during 30-day periods.
(Purdue Exp. Sta. Bull. No. 193.)

quarts of milk, or about four pounds. It is important that the mother's milk be fed so long as he receives whole milk.

The author practices feeding calves whole milk about three weeks. In some instances the change from whole milk to skim milk is begun after two weeks. This depends somewhat on the condition of the calf. In some instances the change from whole milk to skim milk does not occur till the calf is even four or five weeks old. Generally speaking, Holstein calves are able to go on skim milk quicker than are Jerseys and Guernseys. Granting that during the first three weeks the calf is fed whole milk, and that on an average he receives about eight pounds daily, during the latter part of the three weeks he will probably drink 10 pounds daily. This amount of milk will gradually increase from four pounds the first day to 10 pounds the latter part of the three-week period. A specially large calf may need an average of 10 pounds a day during the three weeks.

This means that the calf will drink about 170 pounds of whole milk during the first three weeks. A large calf will drink about 210 pounds of whole milk during the same time.

The changing from whole milk to skim milk should not take place till the calves know how to eat grain, be this when the calf is two weeks old or when he is four weeks old. The change from whole milk should be gradual and should extend over a period of about one week. During this time the calves should be watched carefully. Special efforts should be made to have the skim milk sweet, fresh and of proper temperature. The amount of skim milk to feed varies according to the size of the calf and his condition. The average healthy calf will consume on an average about two gallons of milk per day, or about 16 pounds. When first put on skim milk, he should not receive over 10 or 12 pounds daily, gradually increasing it to 18 or 20 pounds.

A calf may profitably be fed skim milk until he is a year old, if the owner has plenty of skim milk on hand. The calf should in any case receive skim milk till he is six months old. After this time he will thrive well without milk provided he has grain and plenty of roughage. A calf may get along without milk earlier than this. The author has raised calves that received no milk after they were three months old. Such calves, however, receive a considerable setback until they get used to being without milk.

The feed prices charged in making the calculations as shown in table below, are as follows: Whole milk, \$2 per 100 pounds; skim milk, 25 cents per 100 pounds; hay, \$12 per ton; silage, \$4 per ton; and grain, \$30 per ton

*Table Showing Cost of Growing Dairy Heifers to Two Years of Age.

Breed of Cow	Feed cost first year	Feed cost second year	Labor for two years	Bedding \$1.00 per year	Barn rent, insurance, interest and taxes	Value of manure produced	Net cost of heifer to two years of age
Guernsey.....	\$24.41	\$27.88	\$10.	\$2.	\$4.	\$5.	\$63.29
Jersey.....	28.62	26.26	10.	2.	4.	5.	65.28
Holstein.....	28.22	27.21	10.	2.	4.	5.	66.43
Jersey.....	28.18	25.93	10.	2.	4.	5.	65.11
Holstein.....	32.29	28.99	10.	2.	4.	5.	72.28
Average.....	\$28.34	\$27.25	\$10.	\$2.	\$4.	\$5.	\$66.59

*Storrs Agricultural Station Bulletin No. 63.

Changing to skim milk.—The time during which the calf is changed from its mother's milk to skim milk is the critical period in the life of a calf. This is so, not because of any serious danger if proper care is taken, but because there are several factors which affect the calf that are not properly observed.

In the first place, skim milk is not as nutritious as is whole milk. The whole milk contains the butter fat. Besides, whole milk is mother's milk. While, chemically speaking, there may be no difference between mother's milk and some other cow's milk, there is probably a force in

mother's milk that is of value to the calf. The following table shows the composition of whole milk and skim milk and whey, the three products that are many times used for feeding calves.

	Water %	Fat %	Milk-sugar %	Casein %	Albumen %	Ash %
Whole milk...	87.10	3.90	4.75	3.00	0.40	0.75
Skim milk....	90.25	0.20	5.15	3.00	0.60	0.80
Whey	93.00	0.30	5.00	0.30	0.70	0.70

In order to supplement the butter fat, the calf should know how to eat grain. The author never makes the change from whole milk to skim milk until the calf is thoroughly familiar with eating grain. From the standpoint of nutrition, it is not necessary to add any substitutes to the skim milk. The author has at different times fed the various substitutes in the skim milk, but has never had as good success as when the calves themselves eat grain out of the manger in addition to the skim milk.

Calves cannot all be put on skim milk at the same time. A calf that is a little backward does not handle feed well and should not be changed from whole milk to skim milk until he is in the very best of physical condition.

Probably one reason why little calves do not do well on skim milk is that this kind of milk is not always kept in as good condition as is the whole milk. When whole milk is fed it is usually given at once after milking, while fresh and free from contamination. When skim milk is fed, it may be contaminated to a greater or less degree with undesirable germs. On the average farm the chance of contamination is great. The separator is not always in as good and sanitary a condition as it might be. The skim milk may have been contaminated from other cows' milk in the herd. When separated all milk is usually put together. Besides, the skim milk may not be of so uniform a temperature. The skim milk may be allowed to stand around for some time and ferment before it is fed.

Usually if a calf is fed skim milk when about three weeks old, if he knows how to eat grain, and the milk is fed fresh at the right temperature, little trouble is encountered in making this change.

Substitutes for milk.—There are conditions, such as usually prevail in cheese-making districts, when it is almost an economical necessity to avoid feeding either whole milk or skim milk to the calves. Several proprietary mixtures have been manufactured, which, when mixed with a certain amount of water, are considered to take the place of milk for calf feeding and even for feeding pigs. Several experiment stations have experimented with this. Some have been found fairly good. The mixture with which the Pennsylvania station (Bull. No. 60) obtained the best results was Hayward's calf meal. The contents of this mixture are as follows: Wheat flour, 30 pounds; cocoanut meal, 25 pounds; nutrium, 20 pounds; linseed meal, 10 pounds; and dried blood, 2 pounds.

The following shows the proportion of the ingredients used with the different calf meals with which Dr. Lindsey experimented (Bull. 164, Massachusetts station):

LINDSEY'S CALF MEAL I

10 pounds fine corn meal,	5 pounds glucose sugar,
10 pounds flour middlings,	1 pound salt.
15 pounds flaxseed meal,	Cost, 3.2 cents per pound.
10 pounds cheap flour,	

LINDSEY'S CALF MEAL II

25 pounds ground oat flakes,	2 pounds glucose sugar,
15 pounds flaxseed meal,	1 pound salt.
8 pounds cheap flour,	Cost, 3.7 cents per pound.

LINDSEY'S CALF MEAL III

8 pounds fine corn meal,	7 pounds glucose sugar,
10 pounds flour middlings,	$\frac{1}{2}$ pound salt.
14½ pounds flaxseed meal,	Cost, 3.4 cents per pound.
10 pounds cheap flour,	

LINDSEY'S CALF MEAL V

22 pounds ground oat flakes,	1½ pounds blood flour,
10 pounds flaxseed meal,	$\frac{1}{2}$ pound bicarbonate of potash,
5 pounds flour middlings,	$\frac{1}{2}$ pound salt.
11 pounds fine corn meal,	Cost, 3.3 cents per pound.

LINDSEY'S CALF MEAL VI

35 pounds ground oat flakes, $\frac{1}{2}$ pound bicarbonate of potash,
 12 $\frac{1}{2}$ pounds barley malt, $\frac{1}{2}$ pound salt.
 1 $\frac{1}{2}$ pounds blood flour, Cost, 3.3 cents per pound.

In most instances the above were fed in connection with skim milk.

The following table gives a summary of the leading calf meals:

Kind of Ration	Number of calves	Days in trial	Daily gain (lbs.)	Total food cost	Cost of food per pound of gain (cents)
Skim milk in large supply, ordinary grains and hay.....	10	235	1.22	\$22.08	7.7
Skim milk and Hayward's Calf Meal (Lindsey).....	2	173	1.23	20.44	9.6
Whole milk and Hayward's Calf Meal (Hayward).....	12	102	1.18	11.34	9.6
Skim milk and Schumacher's Calf Meal (Lindsey).....	3	150	1.00	12.27	8.2
Whole milk and Schumacher's Calf Meal as per directions (Wing).....	10	132	1.19	13.16	8.5
Skim milk and Blatchford's Calf Meal (Lindsey).....	1*	...	1.15*	....	...
Whole milk and Blatchford's Calf Meal (Wing).....	4	150	.87	17.37	13.5
Whole and skim milk and Bibby's Cream Equivalent (Lindsey).....	3	148	1.21	13.08	7.5
Whole and skim milk and Lindsey's meal I.....	2	147	.97	14.54	10.4
Whole and skim milk and Lindsey's meal II.....	3	183	1.04	14.68	7.6
Whole and skim milk and Lindsey's meal III.....	1	148	1.70	15.24	6.1
Whole and skim milk and Lindsey's meal IV.....	1	148	1.50	14.49	6.5
Whole and skim milk and Lindsey's meal V.....	4	164	1.25	15.12	7.6
Whole and skim milk and Lindsey's meal VI.....	3	157	1.35	16.54	7.6
Average (calf-meal calves)....	48	139	1.17	13.90	9.07

*Not included in the average.

If a calf is raised with the minimum amount of milk, it is probably best to feed the mother's milk and to feed as little whole milk as the calf will get along with, and begin to substitute calf meal as early as is possible. The time when a

calf can get along without milk at all varies with different individuals and with different breeds. The author's experience has been that Holstein calves get along without milk quicker than do Jersey calves, for instance. The physical condition of the calf also has much to do with determining just when a calf can get along without milk. A calf should have milk for at least two or three weeks.

The composition of these different calf meals is given as follows:

	Water	Ash	Fibre	Protein	Extract matter	Fat
Hayward's (not analyzed)	.....	.....	.....	.....	.....	.....
Schumacher's.....	9.34	2.22	1.52	17.15	62.29	7.48
Blatchford's.....	10.42	5.13	6.03	24.91	48.56	4.95
Bibby's.....	7.99	6.23	4.90	16.78	49.68	14.42
Lindsey's I.....	7.37	3.30	2.78	14.98	58.99	12.58
Lindsey's II.....	7.34	3.50	2.93	20.89	56.34	9.00
Lindsey's V.....	6.84	3.55	2.34	17.08	57.64	12.55
Lindsey's VI.....	7.34	3.50	2.14	16.29	65.27	5.46
Clover Leaf Calf Meal.....	10.78	4.43	5.55	25.31	48.53	5.40
Ryde's Cream Calf Meal.....	11.30	4.67	4.50	23.82	51.03	4.68
Sugarota.....	10.33	4.36	3.72	25.35	50.51	5.73

After this time, with careful feeding and care, he can get along without milk, but it will be at the expense of the growth of the calf and the appearance of the calf. The person who expects to raise a good heifer calf to take a future place in the dairy herd should not be too stingy with the whole milk, even though he is getting a good price for it when sold in the market. The extra growth and appearance resulting from being fed whole milk will more than make up for the milk she drinks.

A good calf meal is two pounds of sifted ground oats, two pounds of finely ground corn meal, and one pound of flaxseed.

Calf feeders.—Calf feeders have been advertised and sold. These usually consist of a rubber nipple attached to a container of some kind. The milk is put into the container and the calf sucks the milk from it through the rubber nipple. It is claimed that the calf does not drink his milk so rapidly and that slow drinking is desirable for proper digestion of the milk. It is probable that the calf

drinking out of a pail may drink milk more rapidly than is good for him. He may gulp in a quantity of air. Aside from this, there are probably no bad effects from pail drinking, providing the amount of milk and the sanitary condition of the pail are properly guarded.

Diarrhea in calf.—Diarrhea or scours in calves is probably one of the worst maladies affecting young calves.

There are two kinds of scours :

1. White scours or calf cholera. This is a germ disease. No one knows for sure the nature of the germ that causes the difficulty. Dr. Williams of Cornell University is of the opinion that there is a relation existing between the germs that cause abortion and those that cause white scours (Cornell University Cir. No. 4).

This disease usually shows itself in calves when they are very young, only a few days old. It is claimed that the germ that causes white scours enters the calf's system through the navel at the time of birth, or immediately thereafter. A calf affected with white scours is very weak. White, foamy feces ooze from the rectum. In a short time the calf's eyes begin to look dull and glassy. The disease is fatal in most cases. There is no effective remedy known. The calf is young, and its system cannot stand treatment and medicines.

To prevent white scours, disinfect thoroughly the barn and the stall in which the calf is put. A 2½ percent solution of carbolic acid for disinfecting the cow and the calf is recommended. A five percent solution may be used for disinfecting the barn and the outside of the cow. Some recommend painting the navel of the calf with tincture of iodine at once after birth.

In case there is much trouble with calf cholera in the herd, and the cow freshens in the spring, a good plan is to let the cow freshen in a small pasture near the barn.

Thorough disinfection of the navel of the calf, the cow and the whole barn, is the best preventive. This is a case where prevention is better than cure.

2. Scours due to indigestion. There are many causes of

this form of scours. It may start from a slight derangement of the digestive system. If observed and taken in time, it is not dangerous, especially if the calf is not too young.

Many times scours start at the time that the calf is changed from whole to skim milk.

At times it is caused by feeding cold and warm milk alternately. Uniform temperature of milk is important.

Scours may be caused by keeping the calves in a pen that is wet underneath, or wet above. It is easy for calves to catch cold, if the rain leaks through the roof and gets the calves partially wet. A dry, clean, well-bedded place should be provided.

Scours in calves may be caused by a change of temperature in the room. There are times when little calves are kept in a barn that is warm at night and cold in the daytime. Variation in temperature is very detrimental to calves. A uniform temperature, even though cold, is more healthful than is a temperature that varies daily.

Calves may obtain indigestion and scours by sucking each other, especially by sucking each other's navels. Some male calves excrete urine when other calves suck.

The above are some of the chief factors that are likely to cause indigestion and scours in calves.

Many remedies for diarrhea or calf scours have been used and suggested. The digestive disturbances are due chiefly to the action of undesirable germs in the digestive tract, and also to giving the calf too much to eat during the time of sickness. To remedy the scours, reduce the amount of feed, and secondly, give medicine that will rid the digestive tract of those abnormal fermentations, without poisoning the calf. If the calf has had the disease for some time, and the disease has obtained a firm hold, then first give the calf a physic. Castor oil is highly recommended for this. Give from one to three ounces of this, depending on the age and condition of the calf. This castor oil should be given in about one-half to one pint of milk. If the calf will not

drink it, give it as a drench. Allow about six to eight hours for this to do its work. Then give one teaspoonful of a mixture of one part of salol and two parts of subnitrate of bismuth. Give this with one-half pint of milk, or place it on the tongue of the calf and wash it down with milk. This is known as the Wisconsin remedy for scours.

The formaldehyde treatment is recommended by the South Carolina station. It is given by mixing one-half ounce of formalin with $15\frac{1}{2}$ ounces of water. Use one teaspoonful of this mixture for each pint of milk fed to the calf.

One successful dairy farmer highly recommends the following simple remedy: Put one teaspoonful of allspice in one pint of hot water. Allow it to steep and give the calf the tea six hours apart. Feed no milk until the calf improves.

Do not dope a calf with too much medicine. Give him a dry and clean bed, fresh pure water to drink, a stall in which there is no draft, but plenty of fresh air and light, and reduce his feed as soon as the scours are noticed. If taken in time, these precautions are usually sufficient to cure ordinary scours.

The author has had more trouble from constipation than he has had with scours. If calves are fed regularly and properly, and kept in a dry place, well lighted and well ventilated, and of reasonably warm temperature, there will be very little trouble from scours, but there may be trouble from constipation. Constipation will kill the calf quicker than will a case of scours.

The calves should be watched carefully. When a calf is constipated, give him a rectal injection with warm soft water containing some good soap in solution. This in most cases will cause movement of the bowels. If the calf still continues to be constipated, give him about two tablespoonfuls of castor oil in a pint of milk. The attendant should watch that the constipation does not return after the calf has been purged with the castor oil.

Factors affecting size of cow.—It is important to develop the natural size of the individual. Every individual has a natural limit to which it will grow if properly cared for. If an individual does not reach this limit, through lack of proper feed and care during either its pre-natal or post-natal period, the cow will not have reached its proper point of maximum utility. The chief factors which affect the size of an individual are as follows:

1. Kind of parents. Size is one of the qualities that are hereditary. It is similar to milk and butter fat, color, and any other of the characteristics that are hereditary. If all of the near ancestors are of large size, the calf should inherit this quality.

2. Birth weight of calves. The weight of a calf when born depends on the breed as well as on the individual or strain within the Holstein, Jersey, Guernsey, Ayrshire, Shorthorn and any other breeds of cattle. In practically all cases, the calves that were large at birth were proportionately large at maturity. The author has seen pure-bred Holstein calves weigh 120 pounds at birth and some that weighed only 70 pounds.

Some individual mothers naturally nourish the fetus well during the gestation period, while others are more inclined to put the feed on their own back. Real fleshy cows many times drop very small calves. The feed and care received during the gestation period also affect the size of the calf.

The comparative birth weight of the calves from the different breeds is as follows:*

Breed	No. of Calves	Av. Wt. of Males Pounds	Av. Wt. of Females Pounds	Average of Both Sexes		
				Av. Wt. of calf Pounds	Wt. of Dam Pounds	Wt of Calf to Wt. of Dam Percent
Jersey.....	119	58	49	55	900	6.11
Guernsey.....	57	75	68	71	996	7.13
Ayrshire.....	34	77	74	76	976	7.79
Holstein.....	104	94	85	89	1,153	7.72
Brown Swiss.....	5	107	90	100	1,123	8.90
Dairy Shorthorn...	8	....	....	76	1,249	6.08

* Henry and Morrison

3. Whether the mother is mature or not. A heifer invariably drops calves that are smaller in size than calves dropped by the same cow when mature. This difference in the size of calves varies, and in most cases it varies in proportion to the size of the mother. In the smaller breeds of cattle, such as the Guernsey and the Jersey, this difference in the size of calves when dropped is not so great. It is seldom more than from four to 10 pounds. With the breeds composed of larger individuals, this difference is greater. For instance, a Holstein heifer's calf will weigh about 85 pounds. The same cow when mature will produce calves that weigh about 100 pounds. Lack of size at birth due to age of mothers is usually regained as the individual grows to maturity.

4. Feed and care. This is one of the very important factors to observe in developing an individual to its natural and maximum size. Especially is this true when the individual is young. An individual stunted from babyhood will never recover entirely. A stunted colt is ewe-necked. This abnormal form is seldom overcome, even though the individual is well fed later. It is similar with the calf. It is then very important that an individual during growing years should be fed and cared for in such a way as to have constant and uniform normal growth.

There was a time when it was thought that a calf should be kept lean and partially starved while young in order to develop into a large producing cow. It was thought that if a heifer calf was blocky and showed signs of beefiness, she was developing the habit of laying on meat, and that when such a female freshened, she would retain that characteristic and would not properly convert feed into dairy products.

The production of milk and butter fat is much deeper rooted than this. The author has raised calves that were large, blocky and fat while young, but as soon as they freshened, this was milked off, and they assumed a lean condition. The ability to produce milk and butter fat cannot be

changed to this extent within the time of the life of a calf. If the proper milk and fat heredity is in the blood of the calf, there is no danger in keeping the heifer calf in good flesh.

5. Time of mating. This is another one of the very important factors affecting the size of the individual. Probably there is no one factor that so saps the vitality and the strength from an immatured animal as does early motherhood.

Relation of Weight of Cows to Production (Prof. Woll)

Breed and Weight	No. of Cows	Average body weight lbs.	Fat pro- duced lbs.	Cost of feed	Net returns	Feed units	Pr 100 f'd units	
							Fat pro- duced lbs.	Value of pro- ducts
HOLSTEINS:								
900 lbs. and under...	5	880	415.2	\$89.05	\$47.26	7895	5.26	\$1.73
901-1000 lbs.....	12	948	481.7	92.95	63.91	7865	6.12	2.00
1001-1100 lbs.....	20	1083	479.3	87.76	69.02	7550	6.35	2.08
1101-1200 lbs.....	42	1181	479.4	87.69	70.47	7665	6.26	2.06
1201-1300 lbs.....	25	1274	529.3	94.44	77.98	8145	6.49	2.12
1301-1400 lbs.....	25	1380	524.5	91.31	80.25	8002	6.55	2.14
1401 lbs. and over...	16	1556	566.6	96.60	88.01	8364	6.77	2.21
GUERNSEYS:								
900 lbs. and under...	39	849	382.0	65.71	53.38	6082	6.28	1.96
901-1000 lbs.....	49	956	420.0	69.82	61.31	6273	6.70	2.09
1001-1100 lbs.....	26	1066	438.4	74.39	62.81	6717	6.53	2.04
1101-1200 lbs.....	15	1155	482.0	73.77	76.31	6627	7.28	2.04
1201 lbs. and over...	6	1292	440.8	88.57	49.41	7366	5.98	1.87
JERSEYS:								
900 lbs. and under...	43	842	346.3	52.10	55.76	5432	6.37	1.99
901-1000 lbs.....	21	945	376.0	56.75	60.01	5666	6.64	2.06
1001-1100 lbs.....	7	1057	393.0	50.56	71.35	5271	7.46	2.31
1101 lbs. and over...	4	1200	419.0	59.03	72.27	6027	6.95	2.18
ALL BREEDS:								
900 lbs. and under...	87	847	366.2	60.32	54.20	5866	6.24	1.95
901-1000 lbs.....	82	952	417.8	69.86	61.36	6351	6.58	2.07
1001-1100 lbs.....	53	1071	447.8	76.28	66.28	6858	6.55	2.09
1101-1200 lbs.....	60	1175	477.7	82.81	72.21	7331	6.52	2.12
1201-1300 lbs.....	31	1376	506.2	91.51	72.01	7875	6.43	2.03
1301-1400 lbs.....	26	1379	525.8	92.15	79.64	8051	6.53	2.13
1401 lbs. and over...	16	1556	566.6	96.60	88.01	8364	6.77	2.21

There are, indeed, some who have advocated early mating, chiefly for two reasons. The first is that the calf should be getting into the habit of changing feed into milk early in life. The mammary gland should have an opportunity to develop early, by producing large amounts of milk and butter fat. Secondly, early mating has been recom-

mended so as not to have the heifer loafing about too long without paying for her feed.

Large cows vs. small cows.—There are large cows within a breed and there are also small ones. There have been claims made pro and con as to the profitableness of small cows versus large cows. Usually these discussions have arisen over individuals within the different breeds.

According to the author's experience, large cows of a certain breed are usually larger producers, and more profitable producers, than are the small cows within the same breed.

However, all large cows within a breed are not large producers; neither are all small cows small producers. Individuality is an important factor.

CHAPTER VIII

FEEDING THE DAIRY HERD A BALANCED RATION

Two things are of paramount importance to the dairy farmer. First, the amount and kind of feed that goes into the cow; secondly, the amount and kind of returns that come from her. The feeding of the dairy herd so as to get the maximum returns at the least cost is one of the big problems confronting every dairyman.

The question of economic feeding of the dairy cow may be studied under the following chief heads:

1. Balanced Ration.
2. Succulent Feed.
3. Amount of Feed.
4. Cost of Feed.

Much experimental and investigational work has been conducted with the view of determining just the kind of a balanced ration that will suit each individual cow.

A dairy cow uses her food for several purposes:

1. For milk production.
2. For body purposes.
 - (a) In case of immature cows for body growth.
 - (b) In some instances for increase in body weight.
 - (c) In case of pregnancy for development of the fetus.
 - (d) To keep up body temperature and energy requirements.
 - (e) To maintain the body.

To supply these needs, the cow must have the various food constituents in proper amounts, and the ratio of one constituent to the other should vary according to the needs of the individual cow.

Composition of feeds.—All feeds are composed of water and dry matter. The percentage of each varies greatly.

Not all of the dry matter is digestible. The digestibility of the different feeds also varies greatly. The digestible part of the dry matter is usually referred to as nutrients. They are usually put into three classes:

1. Protein.
2. Carbohydrates (including chiefly starch, sugar and cellulose).
3. Fat, or ether extract.

Protein is essential for milk production. It cannot be replaced by any other nutrient. It is, therefore, important that a dairy cow receives enough protein for milk and muscle production, and probably also for stimulating milk production.

Fat and carbohydrates may take each other's place. These are the chief sources of energy, fat and heat. For these purposes fat is two and one-fourth times as valuable as carbohydrates. Before the fat, or ether extract, can be considered in the same class as the carbohydrates, it should be first multiplied by the factor two and one-fourth.

If an excess of protein is fed, the surplus may be used by the body for the production of energy, but protein is too expensive to be used for this purpose; hence an excess of protein should not be fed. At the same time there must be enough protein in the ration to supply the needs of the cow.

Minerals in a cow's ration.—Minerals are necessary in feeding a dairy cow, but most feeds contain plenty of minerals to supply the various needs. There are, however, some feeds that are quite low in their ash content. The dry matter of good pasture grass contains about three percent of total minerals. The kind of minerals which a feed contains is of as much importance as the total amount. A table in the Appendix gives the composition of the total ash of some of the feeds.

Much important work on the functions of minerals in connection with feeding live stock has been done by Dr. Forbes and his associates at the Ohio station. According to their experiments, when a cow is giving a large flow of

milk there is a loss from the body of calcium, magnesium, and phosphorus; that is, a negative balance resulted. When these minerals were added to the food separately, even then, a negative balance resulted, with the single exception of phosphorus. By feeding phosphorus a positive balance was obtained.

Feeds such as corn, wheat, rye, kaffir grain, feterita grain, kaoliang grain, and sorghum grain are low in total minerals; while feeds such as wheat bran, linseed oil meal, cottonseed meal, oats, malt sprouts, mangel-wurzel, alfalfa hay, and cowpea hay are all high in total minerals. In addition, it will be noticed that these feeds also run relatively high in calcium, potassium, and phosphorus. By studying the table in the Appendix, it will be seen that practically all of the feeds that are high in protein contain a relatively high percentage of minerals. It is not at all improbable that some of the good results obtained in feeding heavy protein rations to a dairy cow are due to the high percentage of minerals which these feeds contain.

In a paper prepared by Miss J. M. Hoover of the Idaho station, it is stated that a cow fed a ration lacking in calcium collapsed and died. It was also stated that pigs fed a ration lacking in phosphorus became very drowsy. One of them slept itself to death. The others, when fed sufficient phosphorus, again became active and normal.

There is some evidence which indicates that a lack of the proper kinds and amount of minerals in a cow's feed may produce abortion.

Cows which have completed large yearly records at times become lame, out of shape, and crippled in other ways. This may be due to the continuous drain of minerals from the body.

Feeding salt.—All vegetable eating animals require some salt in addition to the other minerals in the feed. This point has been thoroughly proven. It is not at all improbable that for large producing cows it will also be necessary to

supply additional calcium, phosphorus and magnesium, in addition to that contained in some of the common feeds.

Vegetable matter contains considerable potassium. The supposition is that this element, when taken into the body of the cow, robs the system of the sodium chloride, or the salt. This theory is strengthened by the fact that meat eating animals do not crave salt. Meat is notably low in potassium.

Dr. Babcock of the Wisconsin station carried on an experiment with the view of ascertaining the results of not feeding salt to a dairy cow. The cows which received no salt became weak, poor of flesh, and rough of hair. The cows receiving salt and otherwise on the same feed remained in good condition. The cows that did not receive any salt in the ration greatly craved this substance. From this experiment Dr. Babcock concluded that three-fourths of an ounce of salt should be fed daily to a dairy cow per 1000 pounds of live weight, and in addition six-tenths of an ounce for each 20 pounds of milk produced.

It has been quite customary to feed salt in limited amounts once or twice per month to the herd. This is not sufficient. By this system, the larger and stronger animals in the herd probably eat more than they should have at one time, and the young stock and more timid members of the herd do not receive enough. Too much salt at one time will in most cases produce scours or other digestive disturbances. The salt should be fed in such a manner and in such quantities as to give all of the animals in the herd free access to salt at all times. This applies to calves and young stock as well as to the cows in milk.

This salt for the herd may be fed in a long water-tight trough, raised about two feet above the ground and placed on solid posts. If the trough is not water-tight, there is too much waste of salt. During a heavy rain it will dissolve in the water and leak away. All calf pens and box stalls should be provided with special salt boxes, so as to give the animals free access to it at all times.

Rock salt placed in the yards and in the pasture is not alone sufficient. Pieces of rock salt are desirable in addition to barrel salt. When cows are full of feed, they often get much consolation from licking a piece of rock salt.

Cows which stay in the stanchion for any length of time may have some small salt brickettes fastened on the stanchion frame in front. These salt brickettes are not nearly so hard as is rock salt.

For milk production.—The amount and percent of the total food consumed in milk production varies with the individual cow, with the amount of milk given, and with the richness of the milk. A small cow giving a large amount of rich milk evidently uses a relatively large percentage of feed for milk production. A large cow giving a small amount of milk uses a less percentage of the consumed nutrients for milk. Some cows will use only about 30 percent of the consumed feed for milk, while others will use as much as 70 percent of the consumed nutrients for milk. The average dairy cow uses about one-half of the consumed feed for milk, and the other half for body purposes.

The more milk a cow produces, the narrower nutritive ratio she needs. In other words, the more milk the cow produces, the more protein in relation to the other nutrients the ration must contain. This is true in respect to the relative amount as well as to the total amount.

The nutritive ratio needed for milk production alone is about one pound of protein to four pounds of carbohydrates, or carbohydrate equivalent. The ration needed for body maintenance is about one pound of protein to eight pounds of carbohydrates. Assuming that a cow uses about one-half of the feed for the body and the other half for milk production, the theoretical nutritive ratio for the average dairy cow should be about one pound of protein to six pounds of carbohydrates (1:6). This, however, varies according to the individuality of the different cows. The feeder must carefully study the cows and should then feed them according to their individual characteristics. The

feeder must not only know the different adaptations and characteristics of the cows, but he must also be thoroughly familiar with the different kinds of feeds. He should know the general chemical composition, the general physical characteristics, and the general physiological effects of the different feeds.

For body purposes.—The amount and percentage of the food consumed, which is used by the cow for the various body purposes, depends much on how the cow is handled.

If a cow must walk a mile or more to and from pasture every morning and night, this will require considerable extra energy, and energy comes from food.

If a cow is forced to grind her own grain, or to eat coarse, unpalatable foods, much energy will be required for mastication and digestion. This will also be a drain on the food eaten to supply the body.



FIG. 57—These cows were in the cornstalks when the temperature was 20 degrees F. below zero.

If a cow is compelled to stand out-of-doors in cold weather, 20 or 30 degrees below zero, and probably "rustle" her own food in the cornstalk field, much heat from the body will escape. This would be an additional factor influencing the amount and kind of feed needed to maintain the normal body temperature of the dairy cow.

Likewise, if a cow is compelled to drink ice cold water, as discussed under a separate head, more feed will be re-

quired to produce the extra heat needed for warming the water.

A cow developing a calf, or fetus, uses some of the consumed feeds for this purpose, although experiments by Prof. Eckles of the Missouri station indicate that this required amount for developing the calf is so small that from an experimental point of view it could scarcely be determined. One thing is sure, that something cannot be produced from nothing. A calf weighs about 80 pounds when born. This

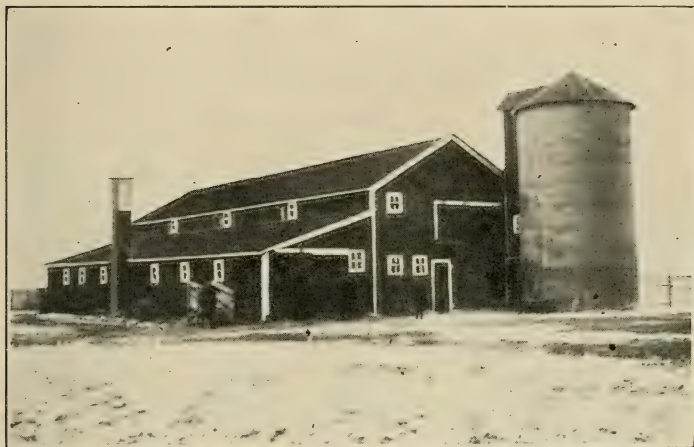


FIG. 58—This barn, though inexpensive, is comfortable and convenient. It shelters a herd of excellent pure-bred dairy cattle.

body would represent, approximately speaking, 30 to 40 pounds of dry matter which can have its source only in feeds given the cow.

Most of the food used by the body of the cow undoubtedly goes to maintain and support the work of the various organs. A cow producing a large amount of milk and butter fat works hard. Her lungs must breathe, her heart must beat, her digestive organs must perform constantly, and the various parts of the body flesh must be maintained at all times.

Young cows need food not only for maintaining the body, but also for growth. Some matured cows gain in flesh. This also would require additional food for body purposes.

Classification of the chief feeds.—Generally speaking, all feeds may be classified under two heads:

1. The principal feeds rich in protein, or in the chief muscle and milk producing substances are as follows:

Concentrates: Oats, bran, linseed meal, gluten feeds, malt sprouts, brewers' grain, buckwheat middlings and bran, cottonseed meal, cake, and feed, beans, peas, distillers' grain; dried blood, and tankage.

Roughage: Alfalfa hay, clover hay, pea hay, bean hay, green oats, grass, green clover, and green alfalfa.

2. The chief feeds rich in carbohydrates and fats, or in the fat, heat, and energy producing substances are:

Concentrates: Corn, barley, emmer, rye, wheat, hominy, buckwheat, kaffir grain, milo grain, feterita grain, kaoliang grain, broom corn seed, millet seed, sorghum grain, and molasses.

Roughage: Timothy hay, millet hay, prairie hay, corn fodder, corn silage, milo maize, kaffir corn, kaoliang, cane, timothy grass, and the various straws.

The above comprise only the chief feeds in use. The composition table in the Appendix is more complete.

The author has seen many dairy cows receive no other feed than a few ears of corn twice each day and all of the prairie hay they would eat. From the above classification it will be seen that both of these feeds belong to the group of feeds rich in fat, heat, and energy producing substances. Such a ration will not contain enough protein to yield a maximum amount of milk. Probably the cow in time and to some extent may adapt herself to such a ration. It is necessary, however, for a cow fed on such a ration to consume too much fat and carbohydrates in order to obtain enough protein to satisfy the demand of the system, and,

secondly, the amount of milk from a given amount of feed is reduced.

A person selects or balances his own ration at the table. He makes his own selection according to the craving of the system. A dairy cow is usually tied and her ration is measured or weighed out for her. She must take what is given her or go without feed. She seldom has the opportunity to make her own selection according to the natural craving of her system.

The need of a properly balanced ration is apparent to every individual. He knows that in cold weather the sys-



FIG. 59—This field produced three tons of alfalfa hay per acre. The dairy farmer should grow his protein feeds.

tem demands foods rich in fat, sugar, and starch, or foods that produce an abundance of heat and energy. During hot weather a person's demand is rather for chicken, beef-steak and cool drinks, or foods that produce muscle and energy, and less fat and heat. This illustrates that the system needs foods that are adapted to the work and the conditions. It is similar with the dairy cow.

Calculation of balanced rations by use of feeding standards.—A vast amount of investigational work has

been done in the United States with a view of obtaining a feeding standard suitable for dairy cows. Several standards have been proposed. They are almost as numerous as are the investigators. There are no conflicts among the investigators as to the principles involved, but the data varies. This difference in results is, undoubtedly, due first to a variation in the adaptation and individual characteristics of the cows used in the different experiments; secondly, to the different climatic and other conditions surrounding the cows; and thirdly, to the different physical characteristics of the feeds and to the composition of the feeds grown under widely different conditions. No one feeding standard will be equally accurate under all conditions and with different



FIG. 60—Alfalfa hay ready to be hauled into the barn for winter feed.

cows. At the same time, feeding standards are very helpful to the inexperienced feeder and helpful in formulating trial rations for cows.

During the last few years, experiments have been conducted and are now in progress which show that there is a difference in the efficiency of the same kind of constituents in the different feeds.*

For instance Professors Hart and Humphrey of the Wisconsin station report that in experiments with dairy cows they found that the proteins of milk have an efficiency of 60 percent for milk production. The proteins of corn have an efficiency of only 40, and the proteins of wheat have an efficiency of 35 percent. The nutritive ratio of the rations fed in this experiment was 1:8. During these experiments, the protein of milk was the only one which showed a positive balance; that is, the cows in the experiments produced less protein in the milk and other products than was given to them in the ration. The cows utilized a portion of the protein for their body. These particular experiments open up an entirely new and important field in the selection of feeds for dairy cows.

Prof. Haecker, of the University of Minnesota, finds that a dairy cow needs seven one-hundredths of a pound of protein, seven-tenths of a pound of carbohydrates and one one-hundredth of a pound of fat to maintain 100 pounds of live weight. From this data the required maintenance ration for any size cow may be calculated.

This standard also provides definitely the amount of each nutrient for each pound of milk of different richness. The average richness of cow's milk is about four percent butter fat. The required nutrients to produce one pound of milk are: 0.0457 of a pound of protein, 0.214 of a pound of carbohydrates, and 0.0159 of a pound of fat. If the nutrients required to produce one pound of milk containing four percent of butter fat are known, then it is plain that the amount of nutrients for any number of pounds of four percent milk can be calculated.

Example.—Calculate a ration for a cow weighing 1200 pounds and producing 40 pounds of four percent milk. (See table in Appendix.)

* L. Mendell and F. B. Osborn, Yale.

* Hart and McCollum, Wisconsin station.

	Lbs. Protein	Lbs. Carbo- hydrates	Lbs. Fat
Nutrients for maintaining 100 pounds of live weight.	0.07	0.7	0.01
Nutrients for maintaining 1200 pounds of live weight	0.84	8.4	0.12
Nutrients for one pound of four percent milk.....	0.0467	0.214	0.0159
Nutrients for 40 pounds of four percent milk.....	1.86	8.56	0.64
Total nutrients for maintenance and for milk.....	2.70	16.96	0.76

The following ration will be needed to supply these nutrient requirements: (See table in Appendix.)

	Lbs. protein	Lbs. carbohydrates	Lbs. fat
15 pounds of alfalfa hay containing	1.650	5.940	0.180
35 " " silage	0.315	3.955	0.245
3 " " ground corn	0.237	2.000	0.129
6 " " " oats	0.552	2.840	0.252
2 " " bran	0.258	0.800	0.068
Total nutrients -----	3.012	15.535	0.874

The nutrients in the above ration are not exactly the same as the requirements. The protein is a little in excess. The carbohydrates are lacking a little but there is an excess of fat. The latter is two and one-fourth times as valuable as the carbohydrates and is therefore carbohydrate equivalent. A small excess of protein may also be used for energy. The ration should contain enough protein. So far as is known, the carbohydrates and fats cannot take the place of protein, but protein may take the place of carbohydrates.

The nutritive ratio of the above ration is 1 : 5.8.

This nutritive ratio is calculated as follows: Multiply the fat by 2.25 to convert the fat into carbohydrate equivalent. Then add this product to the carbohydrates. Divide this sum by the protein and the quotient represents the pounds of carbohydrate equivalent to one pound of protein in the ration.

$0.874 \times 2\frac{1}{4}$ equals 1.9665; 1.9665 plus 15.535 equals 17.50.
 $17.5 \div 3$ equals 5.83.

The nutritive ratio of this ration is therefore, 1 : 5.83.

When the carbohydrates or the second number is large, the nutritive ratio is wide, when it is small or below six

the ration is said to be narrow. The more milk a cow gives, the narrower the ration or the more protein in proportion to carbohydrates is required. The table in the Appendix gives the data for calculating rations for any kind of a cow according to the Haecker standard.

The Armsby feeding standard is based upon more recent investigation.* This feeding standard expresses the nutrients in feeds as digestible true protein and net energy value. The latter is expressed in therms. One therm is equal to 1000 large calories. One calorie is the amount of heat required to raise one kilogram of water one degree Centigrade, or about the heat required to raise one pound of water four degrees Fahrenheit. The protein is pure protein and does not include the amides.

According to the Armsby standard, to maintain a 1200-pound cow a day requires six-tenths of a pound of protein and seven therms. To produce one pound of milk containing four percent of butter fat and 13 percent of total solids requires 0.049 of a pound of digestible protein and 0.27 of a therm. If a ration is calculated according to this standard, for a cow of similar weight and production as was used in connection with the Haecker standard, the following ration would be required for body maintenance:

	Protein Therms	
For body maintenance 1200 pounds live weight----	0.6	7.0
For 40 pounds of four percent milk-----	1.96	10.8
Total required for maintenance and milk-----	2.56	17.8

Using the same kind of feed and the same amount of each kind as in the previous examples the ration stands as follows:

* Bulletin 114, Pennsylvania station.

* Bulletin 459, B. A. I., U. S. Dept. of Agri.

	Protein	Carbohydrates
15 pounds of alfalfa hay -----	1.06	5.13
35 " " corn silage -----	0.21	5.56
3 " " ground corn -----	0.21	2.67
6 " " " oats -----	0.52	4.05
2 " " wheat bran -----	0.22	1.06
Total in trial ration-----	2.22	18.47

It will be noticed that the above ration is exactly like the one provided according to the Haecker standard. Comparing the total amount of protein and net energy with the requirements according to the Armsby standard the above ration lacks about three-tenths of a pound of protein, and contains a little more than a therm too much net energy value. To remedy this some of the corn is subtracted and some linseed meal added. We then have the following which provides about the nutrients required by the Armsby standard for a cow weighing 1200 pounds and giving 40 pounds of four percent milk daily:

	Protein	Therms
15 pounds of alfalfa hay -----	1.06	5.13
35 " " corn silage -----	0.21	5.56
2 " " ground corn -----	0.14	1.78
6 " " " oats -----	0.52	4.05
2 " " wheat bran -----	0.22	1.06
1 pound of linseed meal (O. P.)----	0.28	0.89
Total -----	2.43	18.47

All tables needed in connection with the Armsby feeding standard may be found in the Appendix.

In connection with feeding standards it should be stated that an ideal and final ration cannot be calculated for a cow. The feeder must understand his cows and his feeds, and feed accordingly. A calculated ration is at best only a trial ration.

CHAPTER IX.

FEEDING THE DAIRY HERD A SUCCULENT FEED

A succulent feed is one that contains a large percentage of water combined in a natural way in the food. A succulent feed of some kind is important for the best health of the cow and for maximum economic milk production. A dairy cow needs more water than probably any other animal.

When this water, or a large portion of it, is combined with the feed the entering of it into the body is gradual, and it is continuous with the eating. It can readily be seen that when water is thus taken with the food the consistency of the food when masticated is more uniform. The movement through the digestive tract is more regular. It is laxative in character, and the mastication or bringing the food into condition for digestion is more perfect.

When no succulent feed is fed, the dry feed and the water go into the body separately and at irregular intervals. This means an irregular tax upon the digestive organs of the cow. It means greater energy requirements in mastication. Undoubtedly, a feeder can successfully feed a dairy cow her dry feed and water separately, but it requires more skill and attention on the part of the feeder. With the irregular attention given to the dairy cows on many farms, succulency in the ration is of special importance.

Pasture Grasses

The ideal succulent feed is, undoubtedly, good pasture grass. The degree of succulency of grasses varies with the season. In early spring pasture grasses contain from 65 to 80 percent of water. Later in the summer the water in the various pasture grasses decreases to about 55 to 65 percent.

Another noticeable thing about these grasses is that the further they grow towards maturity the wider their nutritive ratio or the more carbohydrates in relation to the protein do they contain. Blue grass, before heading, has a nutritive ratio of 1:3.3, when headed out 1:6.5, and after bloom it is 1:12. Likewise with alfalfa before bloom its nutritive ratio is 1:2.3, in bloom 1:3.5, and after bloom it is 1:6.6.

The advantages of good pasture are apparent when the cows are turned from dry winter feed on to pasture in the spring. The milk flow increases. The cow sheds the old coat of hair. The vigor and brightness of the whole herd are improved, and their general physical being and poise are bettered.

For at least the Northwest, or the central Northwest, there are several things that militate against the complete success of pasture for dairy cows. In the first place, pasture on high price farming land is not conducive to highest returns. It requires about two acres to produce enough pasture for one cow for the whole season (about five months). If these two acres were plowed up and put into corn for silage, at least 20 tons of corn fodder could be produced. This when made into silage contains enough dry matter and nutrient equivalents to feed one cow for about 18 months; whereas, if left in pasture the two acres will provide only enough feed for one cow for about five months.

Then again, pasture cannot be depended upon every season. For about two months in the early summer, pastures are first class. After that drought often sets in, and feed becomes short. The weather is hot, and flies and mosquitoes are troublesome. As a result the cows decrease in the milk flow and often lose much in body flesh during the latter part of the pasture season.

When these conditions obtain, then the pasture should be supplemented with other feeds, or a system of partial soiling should be adopted. In the "Corn Belt" pastures are usually supplemented with green corn. Some feed green al-

falfa or green sweet clover. The best supplement to pasture, and the cheapest and the handiest and the most healthful to feed, is silage.

The question has often been raised, "Should a dairy cow be fed grain in connection with pasture?" So long as the cows are doing just ordinary work, or so long as economic production only is sought, it does not pay to feed expensive grain in connection with good pasture. If maximum production is desired, at any cost, and the cows are large producers, then a proper selection of grain should be fed in connection with the pasture.

Cows should not be turned out to pasture too early in the spring. The weather at times is cold and wet. The cows may thus suffer cold, especially during nights.

In the spring the pasture ground is many times wet and soggy, and the tramping of the cows will spoil much of the grass and make the ground rough.

So early in the spring grass is scant and many times weeds are plentiful. The latter usually make an earlier start than does the grass. On the prairie, or native sod, wild onion and garlic appear early in the spring. These weeds, when eaten by the cows, taint the milk very badly.

It is a recognized fact that a plant grows from the top as well as from the roots. If the cows are turned on the grass very early, they keep the grass down and prevent its proper growth.

If the grass is not allowed to make some extra growth during the spring, when conditions are most favorable, there will be no reserve food for later in the season, when conditions for the growth are less favorable.

Also a cow turned out very early in the spring, before there is much grass, loses her appetite for dry feed, and there is not enough feed in the pasture. When she gets a taste of grass, then her appetite for it becomes persistent. It is also thought that a cow's teeth are affected by grass so that she cannot bear to chew hay and other dry feeds.

Soiling Crops

Pasture is not the only summer feed that is succulent. Various crops may be sown, cut green, and fed to the cows. This green feed may be cut, hauled, and fed to the cows in the barn. By this system the cows are kept in the barn during the feeding, and let out for exercise only. This involves considerable labor. It is difficult to keep the cows and barn clean. Green feed is laxative, and cows on green feed do not eat much hay. The green feed also attracts many flies into the barn. Considering these things, this



FIG. 61.—Hauling a mixture of green oats and Canadian field peas to a herd of dairy cows. One load per day was hauled.

manner of feeding soiling crops to the herd of dairy cows is rather impracticable, except when practiced in a small way or where labor is plentiful.

The cows may also be kept in the yard and the soiling crop be fed in a rack. Each morning a load of this green feed is cut and hauled and put into the rack. The cows thus have free access to it and at the same time are kept in the fresh air and in a dry, well-drained yard. No additional

labor is required after the feed is once placed in the rack. For a complete system of soiling this is regarded as the most practicable one.

A partial system of soiling is often practiced. Green crops are fed only when the feed in the pasture becomes short. By this system the green crop, usually corn, is scattered on the ground and the cattle pick it up from there. Some of the feed is wasted, but feeding in this manner does away with the labor involved in pitching it into the hayrack, and where the corn is close to the pasture it does away with the labor of loading the feed into the wagon.

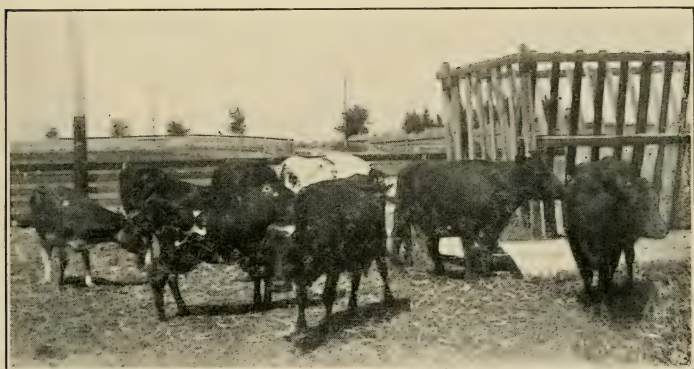


FIG. 62--This lot of nine cows was fed soiling crops in the hayrack during a whole summer.

In Denmark, where soiling crops are used extensively, the cows are tethered in long rows in the field. In some instances the cows will be moved forward every couple of hours. They are thus permitted to eat the crop from the ground themselves. In other places the soiling crop is cut with a scythe or mowing machine and some of the feed is placed in front of each cow. The common soiling crop used in Denmark is a mixture of oats and buckwheat, or oats and field peas.

The author carried on an experiment one summer with 27 cows, divided into three lots. Nine were fed the green

crop in the barn, nine were fed in a hayrack in the open yard, and nine were kept in a pasture. The green crops fed were a mixture of oats and peas, green alfalfa, and corn. Only the first and second crops of the alfalfa were used. The third alfalfa crop was too light, necessitating too much labor, especially considering that when the third crop of alfalfa is ready to cut, the corn crop is just in the right condition for this purpose. The cows fed in the rack in the lot did the best and made the most economic production.

The amount of green feed that a cow will eat depends much on the cow and also on the crop. Generally speaking, a mature cow will eat about 110 pounds of green feed per day.

The table below shows the average production of the green feeds raised on the South Dakota state college dairy farm. For soiling purposes a system of oats and Canadian field peas, alfalfa, and corn is best. The first crop of alfalfa is ready to use about June 10. The latter part of June, the mixture of oats and peas may be cut and fed. By seeding this crop about two weeks apart, the oats and pea crop can be used for a considerable time and still remain at

Crop	Green yield per acre, lbs.	Dry matter per acre, lbs.	Digestible (D. M.) per acre, lbs.	Date harvested
Oats and peas followed by millet.....	30,820	6,722	4,253	June 25 and later
Total per acre oats, peas and millet.....	7,940	2,190	1,212	Sept. 10 " "
Corn.....	38,760	8,912	5,465	Aug. 20 and later
Alfalfa:	25,540	5,593	3,754	
1st crop.....	10,580	2,647	1,315	June 15 and later
2d ".....	9,760	2,444	1,382	July 15 " "
3d ".....	5,080	1,265	771	Sept. 5 " "
Total per acre of alfalfa.....	25,420	6,356	3,468	

the right stage of maturity. If there is an excess of this crop, it can be cut for hay or left for maturity. This crop, if not too heavy and tangled, may be cut with a self-binder. If the bundles are not tied too tight and too large, they will

dry out in the shock, and it makes the very best of hay for winter feeding. The second crop of alfalfa may be used after about July 10. After the middle of August the corn crop may be used until about the middle of September, sometimes longer, depending on the frost.

The yield reported in the table above is probably greater than can be expected from average land. The land on the college dairy farm is rich and in a high state of fertility.

On account of dry weather during the month of July, the millet crop failed once in four years. The data in the table, therefore, represent the average of only three years. The remainder of the table gives the average for four successive years.

The oats and peas were taken off the land for soiling crops or for silage, or for hay, about July first. This same ground was then thoroughly disked and seeded with millet. In this manner two crops of green feeds were obtained from the same ground. The latter crop was usually cut for hay about September 10, or about the time that frost usually appears.

In accordance with this yield, one acre will produce enough feed in the form of soiling crops for two cows for about $4\frac{1}{2}$ months. The greatest drawback to the general use of soiling crops is probably the extra labor involved. Its chief advantages are large yield (which means a saving of land or the keeping of more cows) and cleaning the land of weeds.

At the Wisconsin station, it has been proven that one acre used for soiling crops is equal in ability to produce food to $2\frac{1}{2}$ acres of pasture.

Roots

For winter feeding there is probably no succulent feed better than roots. If a cow is on full feed for maximum production, roots of some kind are almost indispensable.

Roots, however, are expensive to raise. Much labor is necessary in weeding them and hoeing them, and this labor

comes during the part of the summer when the average farmer is busiest with the other field crops.

Many dairy farms do not have a suitable place in which to store roots so as to keep them from spoiling and at the same time to protect them from frost.

A cellar under the barn, or bins in the center of the barn, where the temperature does not vary too much, and does not go below freezing, are suitable for storing roots.

In spite of these disadvantages, every cow owner should plan to raise a small patch of roots each year, even if not more than can be used for test cows and for cows that may become ill and lack in appetite.

The author has raised and fed mangel-wurzels, sugar mangel-wurzels, carrots and turnips. Of all these, he prefers the mangel-wurzels. A larger and surer yield is obtained if properly tended. In average years the yield of mangel-wurzels should be about 22 to 30 tons per acre. These roots are also easily harvested. The long taproot characteristic of the other kinds is not present in the mangel-wurzels. A large percentage of these roots grow above ground and they can be pulled out by hand without the use of a digger or plow.

When Hester Aaltje Korndyke made the world's seven-day record for production, 621 pounds of milk and 37.4 pounds of butter fat, she consumed daily about 130 pounds of roots. This may be regarded as about the maximum amount of roots that a cow can consume per day. A good feed of roots per day is about 50 pounds.

When roots are fed to individual cows on heavy feed for maximum production they are usually sliced lengthwise and the grain poured over the roots. When fed to the herd, they may be given whole. Cows soon learn to eat them that way. Some dairy farmers put them into a wooden box and cut them with an S-shaped knife. The resulting pieces are of different shapes and sizes. In some instances pieces of roots will lodge in the gullet or throat of the cows and choke them.

In such cases it is necessary to remove the lodged piece of root. At times it may be dislodged by gently manipulating the throat on the outside with the hands. If this does not remove the root, take a piece of one-inch rope, untwist about one inch at the end and tie a piece of cord around it about one inch from the end, so as to form a soft tuft at the end. Then insert the end of the rope into the gullet and gently work it until the piece of root is dislodged. Some have accomplished the same by the use of a broom handle, but the rope is flexible, safe, and much easier on the cow.

Special root slicing machines are now on the market. These machines are rapid and efficient. They can be purchased at a reasonable price. Where roots are fed regularly on a large scale, it pays to have one of these machines.

Mashes

According to the previous definition of a succulent feed, mashes cannot be regarded as succulent feeds. Nevertheless, they will be briefly considered here. The author has, as a rule, not practiced feeding grain in the form of mash, yet with some cows mashes are very successful. It is not all cows that like to eat grain in this form, but usually they learn to like it. Aged cows with poor teeth can usually be made to improve in production by being fed grain in the form of a mash. Such cows also keep up their flesh better, a fact which shows that they digest the grain better in that form than when dry.

A mash is prepared by first weighing out the proper amount of grain in a water-tight container and then pouring scalding hot water over it. Enough water is added to moisten all of the grain and enough more so that some water is standing on top. This moistened or scalded grain is then left to steep 10 or 12 hours, or until the next feeding time, when it is fed. New feed is then prepared again.

In the absence of any strictly succulent feed, with an aged cow, and one that likes it, and with an individual that warrants the extra labor, such a grain mash is desirable.

Wet brewers' grain is a good milk-producing feed, but it must be fed fresh. It should not be hauled and piled up any length of time before it is fed. Brewers' grain kept in this condition will soon sour and spoil. When fed in a spoiled condition it taints the milk. It also produces a strong undesirable odor around the premises.

Dried beet pulp is used very extensively by dairy farmers. This is a by-product of the sugar beet factories. When this dry beet pulp has been steeped in water for a short time it is a splendid feed. Use one part of dried pulp to four parts of water. Cold water is generally used. Allow it to stand until the pulp is entirely saturated before feeding. This latter feed, as with most mashes, cows usually have to learn to like. When they once learn to eat it, they become very fond of it. Dried beet pulp is laxative in its effect.

It is important that all mashes be made up daily. Do not allow them to stand around and ferment, and do not mix them in an old dirty container.

Silage

For a full year, and one year after another, there is nothing that can take the place of silage as an economic, handy, and healthful succulent feed. As a feed, silage serves the cow in much the same way as canned fruit and vegetables serve the household. Practically any of the coarse feeds may be cut and stored in the silo. A silo, then, is a container and preserver of moist rough feed. This container keeps stored feed from coming in contact with the air, and thus preserves it.

The feed stored in the silo is called silage. This feed usually consists of crops harvested and cut just previous to maturity, while still green. However, it should be understood that rough dry feeds may also be stored in the form of silage by adding the proper amount of water.

It should also be understood that it is not absolutely necessary to cut the green crops into small particles in order

to obtain silage. The author saw a whole field of barley struck by a hailstorm just previous to maturity. What remained was cut and all of it was raked up and put into a pit silo without being cut in pieces. This made useful feed. It is also possible to pack corn bundles into a silo and have them keep without running them through a silage cutter. Green corn bundles have been stacked outdoors and good silage resulted. However, much of the corn fodder spoils. Except in emergencies, however, the crop for silage should be cut.

Chief advantages of silage.—The chief advantages of silage for the dairy farmer are:

1. The crop for the silo is sure. Such a crop is not seriously injured by late spring, early fall, storms, or by wet or dry seasons.

2. All of the corn plant stored as silage is utilized. About 62 percent of the full

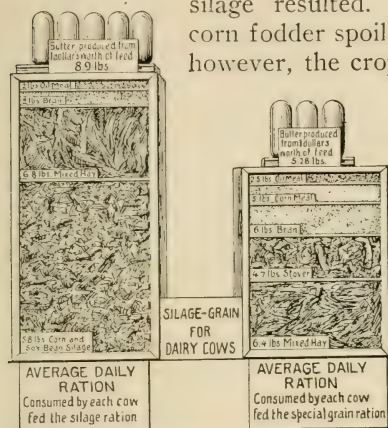


FIG. 63—Showing economy of silage in a ration for dairy cows. (Ohio Exp. Sta.)

value of the corn is in the ear and about 38 percent is in the stalk and leaves. Without the silo, most of this latter is wasted. Considering the succulency, the increased digestibility, and palatability, some authorities have stated that the cornstalks in the silage equal the ears in the crib for feeding purposes. The silo puts rough feeds into a form which cows and young stock can handle most economically.

3. More feed can be raised to the acre in the form of silage. This is true in the first place because corn intended for the silo can be planted thickly on rich or well-manured ground. If the land is not weedy the corn can be drilled in, and thus yield on an average from $1\frac{1}{2}$ to two tons more feed per acre than would otherwise be the case. In the

second place, a larger variety of corn, though not of the extremely large kind, can be planted. On the South Dakota state college dairy farm the average tonnage per acre for the last five years is about 12 tons. The highest yield ever produced was on a heavily manured five-acre patch, which yielded 17 tons of silage corn per acre. The crop was so heavy that the cornbinder could not cut it without much bother.

4. Feed in the form of silage can be stored in less space than can any other form of roughage. Approximately speaking, one ton of hay occupies 400 cubic feet of space. A ton of silage occupies only about 50 cubic feet, or an eighth as much space. In this connection it should be stated that a given volume of silage contains less dry matter than does an equal volume of hay. Comparing the two on a basis of dry matter, about twice as much feed can be stored in the form of silage as in the form of hay in a given space. A ton of hay, occupying about 400 cubic feet of space, contains about 1800 pounds of dry matter. Eight tons of silage, occupying about an equal space, contains about 3200 pounds of dry matter, or very nearly twice the amount that is stored in the form of hay in a similar amount of space.

5. Silage furnishes a succulent feed that may be used any time during the year. This is of special value in connection with the dairy herd. Silage is of special value as a winter feed and during the late summer as a supplement to pasture. One may stop feeding it any time, or begin feeding it any time. Silage may be kept over from one season to another, and from one year to another, making it valuable as a hold-over feed from a season of large crops to a season of small crops.

6. Corn to be put into the silo may be taken off from the ground early in the fall, thus clearing the land and putting it in good shape to be plowed and prepared for a succeeding crop. In this connection it might be stated that some experiments tend to show that the vitality of the weed seeds

is destroyed in the silo. This, however, has not been completely proven.

7. Silage is healthful and palatable. If it is in good condition, and properly fed, it is a regulator as well as a nourishing food. Malnutrition is minimized in a herd receiving silage as compared with a herd receiving dry feed entirely. Silage is appetizing to a cow. Young stock receiving silage will consume considerable good straw. When no silage is fed, cattle eat very little straw without being starved to it. For dairy cows, alfalfa hay and corn silage make almost an ideal combination of rough feed.

It has been stated at times that silage rots the teeth of a cow and wears out a cow's digestive organs. The writer has fed corn silage to the South Dakota state college dairy herd for 12 consecutive years, and throughout the whole year, the herd having no pasture. The aged cows in the herd are today in at least as good condition as are other cows of similar age in this community that have had no silage.

It is entirely probable that aside from the nutrients, the lactic acid and other fermentative products have very desirable effects on the digestion, absorption, and assimilation of the food of a cow. Normal corn silage contains about $1\frac{1}{2}$ percent of acid. A cow eating about 35 pounds of silage per day consumes about eight ounces of pure acid daily. Undoubtedly, this acts as a subduing force to undesirable fermentation in the digestive tract.

Filling the silo.—During the last 10 years the writer has been experimenting with the use of the different crops for silage. The following crops have been grown, stored as silage, and fed to the dairy herd: Various kinds of dent corn, dent corn seeded together with soy beans and cowpeas, kaffir corn, milo maize, amber cane, Sudan grass, and a mixture of oats and Canadian field peas. Without going into detail in respect to results, it may be stated that the best success was obtained with the dent corn. Of the various kinds of dent corn tried, a variety known as the Climax, grown to maturity in the southern part of the state of South



FIG. 64—Filling the silos at the South Dakota state college dairy barn. These different kinds of silos hold about 450 tons of silage. The college dairy herd has no pasture. It is fed silage throughout the year as a succulent feed.

Dakota, has proven to be the heaviest and most consistent yielder. In most seasons this corn will mature in this latitude.

Of the various other crops grown, milo maize and kaffir corn proved to be second best. These crops are especially suitable in the semi-arid sections. None of the cane varieties produce as palatable silage, nor do they produce as heavy a yield as the corn.

The mixture of oats and field peas in favorable seasons yields very heavily. If this crop is not hauled at once after cutting, while green and tender, it does not cut well in the



FIG. 65—Cutting the corn with a corn binder. One man and team cut about eight acres in one day.

silage cutter. Unless the knives are very sharp, there is a tendency for this crop to be cut too long, and for it to wind around the knives and various axles while the cutting machine is in operation. It is almost impossible to feed it so that the cutting box is full all the time. When the cutting box is not full, then there is a tendency for the knives to pull it out and not cut it.

Neither did the author have good success in seeding cowpeas and soy beans with the corn. It was difficult to obtain a stand with the soy beans and cowpeas, and these crops grew so low that it was difficult to cut them and retain them in the bundle with the cornbinder. In a lower altitude and in a latitude further south these crops may grow well in connection with corn.

The corn is harvested with the ordinary cornbinder. The bundles should be tied small, so they will pass through the cutter without being separated and so they can be easily handled.

The corn bundles should be hauled on low trucks having a flat rack, to do away with too much lifting.

If the cornfield is close to the silo, the following filling crew works economically:

4 teams and men for hauling corn fodder to the cutter.

2 men in the field, besides the drivers, for pitching bundles.

1 man to help the drivers to unload at the silage cutter.

1 man spreading the cut silage with a distributer and packing the silage in the silo.

1 man to look after the running of the gasoline engine and the cutter.

1 man to feed the cutter.

Such a crew will cut about 80 tons of silage per day, and it may cut as much as 100 tons.

The engine should be of ample power, about 15 to 20 horse power. The cutter should be of sufficient capacity to handle a whole bundle at a time. It is better to underfeed a large cutter than it is to overfeed a small one.

The corn should not be cut until it has grown to maturity. This does not mean that it should be dried up before it is cut. The best stage at which to cut the corn is when the lower part of the stalk and leaves have begun to wilt and turn dry. When that happens, then no more food passes into the cornstalk from the roots. At this stage, usually about a third to a half of the kernels have dented. The corn



FIG. 66.—Hauling corn fodder on a low wagon from the field to be cut for silage.

Percent protein.....	25.31	2.43	16.05	13.47	8.76	11.10	7.48	8.94	5.18	9.73	4.89	9.49	4.70	10.32	4.65	9.45	3.95
Percent carbohydrates.....	58.92	61.88	73.39	82.10	83.66	84.25	84.37	85.26	86.13	84.84	87.38	84.74	87.01	83.66	87.63	84.80	89.45
Percent fat.....	3.63	5.43	1.88	1.23	1.06	2.64	1.02	4.09	1.04	3.87	1.83	4.30	1.00	4.56	1.84	5.74	8.82
Lbs. dry matter in one acre.....	6.9	730.6	2244	754	3812	2267	3903	3866	4238	4625	4363	5183	4225	5266	3989	4605	2654
Total pounds dry matter.....	6.9	730.6	2244	754	3812	2267	3903	3866	4238	4625	4363	5183	4225	5266	3989	4605	2654
Pounds protein.....	1.75	149.3	367.0	101	4567	271	6172	346	8104	219	450	210	492	199	543	116	435
Pounds carbohydrate.....	4.77	472.1	1647.5	620	3190	1911	3295	3227	3650	3924	3761	4395	3678	4406	3494	3905	2337
Pounds fat.....	2.5	39.70	143.2	9	40	55	40	158	44	179	36	223	42	237	33	159	22
Six blades June 16		Four feet high July 24		First tassels appear Aug. 6		Corn and cob		Stalk blade		Corn and cob		Stalk blade		Corn and cob		Stalk blade	
Silks drying Aug. 28		Silks brown Sept. 19		Glazing stage Sept. 24		Ensilage stage Oct. 1		Ready to shock Oct. 8		Shock corn ready for husking Nov. 12		Left standing in field to husk Nov. 12		Stalk blade		Stalk blade	

should have enough of the natural water in it to pack and ferment without the addition of extraneous water. It must not be cut so green that the silage will not hold its own juice. From the above-mentioned data one can easily calculate the cost of filling the silo.

The accompanying table of analyses, taken from Bulletin 175 of the Indiana station, will show the development of the corn plant from the time it comes up until maturity.

A machine has now been manufactured which husks and separates the corn ears, and cuts only the fodder for silage.

Many silos are now refilled late in the fall with dry corn fodder or corn fodder cured in the shock in the field. When such dry corn fodder is put into the silo, considerable water must be added. The amount of water needed is about equal to the

amount of corn fodder cut. For each ton of corn fodder, use about 250 gallons of water. When frost does not interfere, the best way of adding the water is to let a continuous stream run into the space where the fan operates. This distributes the water evenly. Pack the silage thoroughly in the silo.

Sealing the silo.—One or two days after the silo has been filled, the contents will have settled considerably. The finer the silage has been cut, and the more carefully it has

been distributed and packed, the less settling there will be. If possible, the filling machinery should be left in place or brought back so that the silo can be refilled.

During the first week after filling, someone should make it a point to go into the silo every day and thoroughly tramp the silage down, otherwise the silage in the lower part of the silo will settle and leave the top part open or porous. This admits air into the surface silage and causes it to spoil. It is a good plan to wet the surface of the silage every day when the tramping is

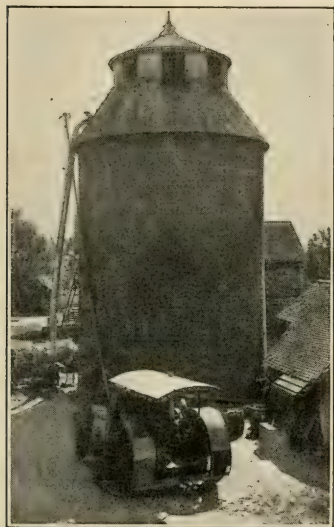


FIG. 67—Filling a 300-ton silo.

done. This will help to pack the top of the silage and exclude air from it.

Some prefer to seal the silo by running a load of straw through the cutter the last thing. This cut straw is distributed over the surface, moistened, and tramped down thoroughly.

When a silo is opened, the spoiled silage should be hauled

to some place where the cattle cannot obtain access to it. Moldy and spoiled silage is likely to poison the cows.

Silage fermentation.—During the first 10 or 12 days fermentative and chemical changes take place. When the oxygen contained in the cut corn fodder is used, the decomposition or changes practically stop. When silage is first put into the silo there is a development of carbonic acid gas. This gas is heavier than air. In concentrated form it is poisonous. A partially filled and closed up silo may contain enough of this gas to be dangerous. A partially filled pit silo is more dangerous in this respect.

The temperature of the silage is slightly increased during the first few days. The rise in temperature, however, is not so great as is generally supposed. In the top portion, which is exposed to air, the rise in temperature is great. The highest temperature recorded in this part of the silage is 135 degrees F.

During the winters of 1912 and 1913, the author and D. H. Bailey, dairy chemist, made temperature observations in the different parts of the silage. Maximum and minimum thermometers were placed in the silage directly in the center and 2 feet from the edge. Vertically, these self-recording thermometers were placed 3 feet from the top, in the middle of the silage, and 3 feet from the bottom. In addition, two self-recording thermometers were put in the

Silo	3 ft. from top				Center (Vertically)				3 ft. from bottom			
	Center		2 ft. from edge		Center		2 ft. from edge		Center		2 ft. from edge	
	Max. F.	Min. F.	Max. F.	Min. F.	Max. F.	Min. F.	Max. F.	Min. F.	Max. F.	Min. F.	Max. F.	Min. F.
Cement	100.5	62.0	106.5	61.5	77.7	37.7	77.2	36.0	79.0	32.5	86.5	30.0
Tile	106.0	47.0	125.*	30.0	84.5	53.5	83.0	72.5	84.0	38.0	83.0	40.0
Wood	No observations made (Fed out early)				94.0 50.0 94.2 58.0				69.0 40.0 72.0 36.0			
Staves												
Average of all silos	103.3	54.5	115.7	45.7	85.4	47.1	84.8	55.5	77.1	55.5	80.5	35.3

* Silage partially spoiled due to air pocket.

silage at different places—one near the top in the silage that spoils, and one deeper in the silo where the silage does not spoil. These self-recording thermometers were placed in boxes in the silage at the time the silos were filled. This was done to protect them from being broken. The self-recording thermometers would record for seven days without being wound. The results of these self-recording thermometers are not considered complete, and on account of rust interfering with their proper working, the results are not considered sufficiently accurate for publication.

The results from the maximum and minimum self-recording thermometers are considered normal, and are published in the preceding table.

These observations were taken in three kinds of silos: Monolithic, wood stave, and double hollow tile block. The above data represents the average of all silos.

The by-products formed during these changes of the silage are chiefly lactic acid, acetic acid, and alcohol. The amount of alcohol in the silage varies between one-tenth percent and four-tenths percent of the weight of the silage. This is equivalent to about five-tenths percent of the silage juice.

This formation of alcohol comes about in connection with the production of acid from the sugar. The sugar is first broken up into simpler sugars, such as glucose. These are then changed into acids, alcohol, and gas. The amount of sugar in the plant may be increased or may be formed from starch to some extent, but most of the sugar is contained in the plant at the time it is put into the silo. This amount is greatest when the plant is green. The further the plant develops into maturity, the less sugar there is in it. On this account, corn silage cut late does not become so sour.

The alcohol formed is mostly changed into acetic acid after the silage has been kept a while.

In addition, a variety of aromatic substances is formed. These various juices in the silage come about chiefly during

the first four or five days. At the end of 10 or 12 days, the changes are practically complete.

Enzymes, bacteria, and yeasts are the joint causal agents responsible for the changes occurring in silage. Bacteria are the chief agents in the formation of lactic acid from sugar. The small amount of alcohol found in silage results in part from the action of yeasts and also to the enzymes present in the plant.

Feeding the silage.—Silage is pre-eminently a feed for dairy cows and young cattle. It may be fed in the barn, in

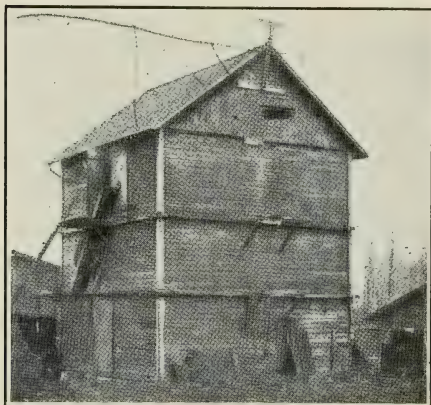


FIG. 68—This silo was built in 1894 to preserve feed for a herd of Red Poll cattle. This was probably the driest year ever seen in the west.

mangers, in sheds, and in troughs in the open. Silage is easily handled. The customary way of feeding is to load it into a cart which can be wheeled in the feeding alley in front of the cows.

The average cow will eat about from 30 to 45 pounds of silage per day. This means about half a ton for each mature cow per month.

This is a fair calculation on which to base the size of silo and area of corn needed for silage.

During the last 10 years the South Dakota state college dairy herd, under the supervision of the author, has been fed silage constantly. The cows in milk receive their silage in the barn during the whole year. During the summer the dry cows and young stock are fed their silage in a manger running the full length of a shed directly in front of the silos. The rack in the exercise yard always contains plenty of good hay. The South Dakota state college dairy farm

now produces no other feeds than corn for silage and alfalfa for hay. About one acre of mangel-wurzel roots is raised each year. These are fed chiefly to test cows.

The author once practiced feeding silage to all animals in the dairy herd, but he has now discontinued feeding it to service bulls and young calves. Experience has taught that bulls fed heavily on silage become sluggish and slow breeders. Calves should appear smooth, bright, and have glossy hair. Such a condition does not result from feeding young calves silage. After they are past six months of age silage seems to affect them favorably if fed in moderate amount, and if they receive additional grain.

In the Northwest, and during the latter part of the winter, considerable trouble is encountered with frozen silage. The common idea prevails that the kind of material from which the silo is built and the manner of construction of the silo have marked effects on the amount of frosted silage. From experiments with practically all of the leading types of silos, it is safe to say that there is not much difference in the amount of frozen silage. The silage will freeze some in all of the silos in this latitude. Silage freezes from the top as well as from the sides. During the latter part of the winter the silage will freeze from 6 inches to 2 feet from the outer edge. Silos placed to the northwest of the barn will have the silage frosted more than those placed on the south side of the barn. The silage on the north and northwest sides of the silo will also freeze more than will the silage on the protected south side. In a silo of small diameter the silage freezes more than in one of larger diameter.

A small amount of frozen silage will not injure the cow, but if she is forced to eat too much of it at one time digestive troubles may result. Bloat quite commonly results from eating too much frozen silage.

The only silo in which silage does not freeze in this latitude is the pit silo.

To have the minimum amount of frozen silage, the center of the silage should be kept high and the outer part low. The surface should be convex instead of concave. Load the feed cart from the center every day. Then with a sharp spade or similar instrument proceed to take off a couple of inches of the frozen silage and throw it into a pile in the center. The lower part of this frozen silage will thaw and the top part will serve as a protection against additional freezing. Next feeding time load from the center again and then take off some more frozen silage, and so on.

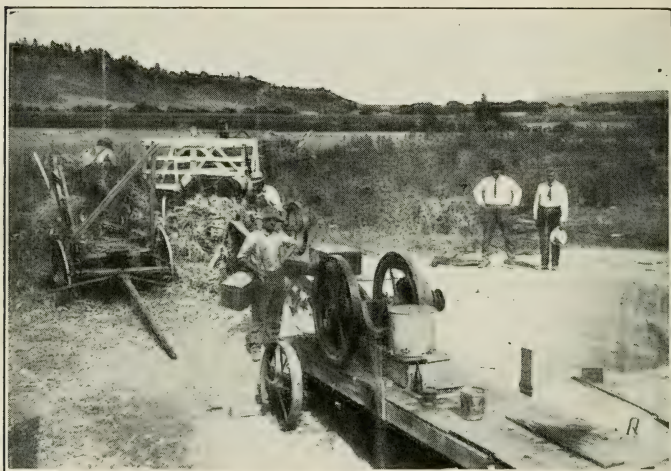


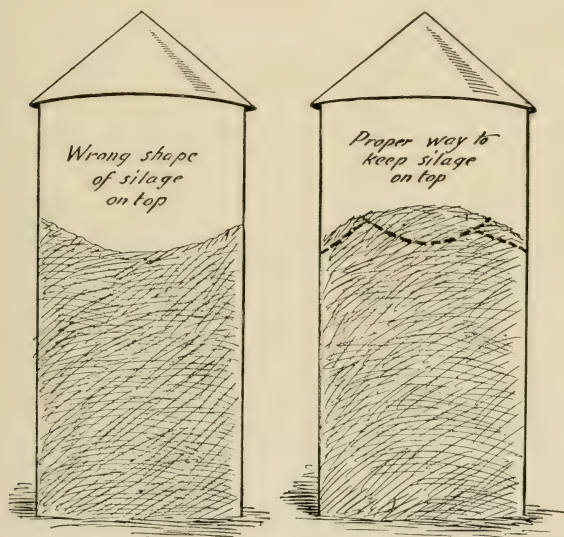
FIG. 69—Filling a pit silo in western South Dakota.

Some feeders avoid the frosted silage and continue to feed from the non-frozen portion. This results in a wall of frosted silage near the circumference of the silo. In the fore part of the winter this wall of frozen silage is thin, but as the winter continues the frost intensifies, the heat resulting from fermentation and chemical changes has been exhausted, and this wall of frozen silage becomes much thicker. This method leaves a bowl-shaped hole in the center and much frozen silage near the outside. When

warm weather begins, the silage thaws and pulls away from the silo walls. Air gets into it from all sides and it spoils so rapidly that it cannot be fed while in good condition.

Silage should preferably be fed just after milking, in order to avoid saturating the barn with silage odors during milking time. If silage is fed before milking, the barn should be thoroughly aired again before milking begins. Milk readily absorbs foreign odors present in the barn atmosphere.

There was a time when it was thought that silage fed to cows produced silage-tainted milk, no matter how it was



FIGS. 70 and 71—Improper and proper way to keep silage on top to minimize frosted silage.

fed. There appears to be very little foundation for this belief. If spoiled or partially spoiled silage is fed to milch cows, no doubt the milk becomes tainted.

Kinds of silos.—There are many different forms of silos and so many different kinds of materials used in silo con-

struction that it will not be practicable in this connection to make an extended study of them nor of all the details of construction.

Briefly it may be stated that the round silo is now considered to be the best. The square or rectangular was used considerably at one time. In this latter form of silo, the silage in the corners usually spoils. It was also found difficult to keep this form of silage from spreading.

Silos are built from wood put together in different ways, from concrete, hollow tile blocks, brick, ordinary rock, lath and plaster, and metal. Any material which will keep air-tight, stand the pressure, resist the action of silage acids, and in some measure resist the cold, is suitable.



FIG. 72—It is inconvenient to feed corn from the stack, though it gives better results than to turn the cows into the field of cornstalks.

Silos of the different construction materials, eight leading types, have been built at the South Dakota station (monolithic, double hollow tile block, vitrified tile block, concrete anchor block, concrete stave, concrete interlocking, solid blocks, wood stave, and wood silos made from studdings boarded up horizontally inside and outside) with a view of ascertaining comparative efficiency and cost. From a standpoint of keeping silage, no difference could be observed in

the different kinds of silos. The silage has kept well in all of them. Although some of these silos have been in use only three winters, and some as long as ten successive winters, from numerous observations it is clear that a great deal of latitude can be exercised in the selection of silo construction material. The manner and thoroughness of construction and quality of construction material are two factors of greater importance than is the kind of material.

Conditions such as the price of lumber, proximity to a brick or tile factory, nearness to suitable gravel, price of



FIG. 73—The benefits of silos and silage told to the people of South Dakota from a special train.

cement, suitable help and permanency desired in silo, all have a bearing in deciding what kind of construction material to use.

In case a permanent silo is desired, the monolithic type is probably the cheapest, if cement can be bought at a reasonable price, if one has access to good gravel and if proper reinforcement is used. If one is located not too far from a tile and brick yard, so that the freight is not too high, such a silo of these materials is very useful.

If a renter desires to build a silo, and wishes to take it with him when his lease expires, then probably a wooden silo is best. The latter kind must be anchored to a good concrete foundation and be stayed by means of guy wires at the top to make it safe during dry and windy weather. Wooden silos do not hold their shape so well and do not last so long as do the permanent types of silos.

Table Showing Capacity of Round Silos in Tons.

Inside height of silo	Inside Diameter of Silo.											
	8 ft.	10 ft.	11 ft.	12 ft.	13 ft.	14 ft.	15 ft.	16 ft.	17 ft.	18 ft.	19 ft.	20 ft.
20 ft.	17	26	30	38	44	51	59	67	.....	.....	.....	.....
21 "	18	28	33	41	47	55	63	72	.....	.....	.....	.....
22 "	19	30	36	43	50	59	67	77	86	.....	.....	.....
23 "	20	32	39	46	54	63	72	81	92	103	.....	.....
24 "	22	34	41	49	57	67	76	86	98	110	122	.....
25 "	23	36	43	52	60	71	80	91	104	116	129	143
26 "	24	38	46	55	64	75	85	97	110	123	137	152
27 "	25	40	49	58	68	79	90	102	116	130	145	160
28 "	27	42	51	61	71	83	95	109	122	137	152	169
29 "	28	44	54	64	75	87	100	114	128	144	160	178
30 "	30	47	56	67	79	91	105	119	135	151	168	187
31 "	31	49	59	70	83	96	110	125	141	158	176	196
32 "	33	51	62	74	86	100	115	131	148	166	184	205
33 "	35	53	65	77	90	105	121	137	155	174	192	215
34 "	36	56	68	80	94	109	126	143	162	181	200	224
35 "	37	58	70	84	98	114	132	149	169	189	209	234
36 "	39	61	73	87	102	118	136	155	176	196	218	243
37 "	40	63	76	90	106	123	142	161	183	204	227	252
38 "	41	66	79	94	110	128	148	167	190	212	236	262
39 "	43	68	82	97	115	133	154	173	197	220	245	272
40 "	45	70	85	101	119	138	160	180	204	228	255	282
41 "	.....	72	88	105	124	143	166	187	211	236	262	291
42 "	.....	74	91	109	128	148	172	193	218	244	270	300
43 "	.....	.....	.....	113	133	154	179	201	225	252	280	310
44 "	.....	.....	.....	117	137	159	184	207	233	261	289	320
45 "	.....	.....	.....	.....	.....	165	191	215	240	269	298	330
46 "	.....	.....	.....	.....	.....	170	197	222	247	277	307	340
47 "	.....	.....	.....	.....	.....	.....	.....	229	254	285	316	350
48 "	.....	.....	.....	.....	.....	.....	.....	236	261	293	325	361
49 "	.....	.....	.....	.....	.....	.....	.....	.....	.....	301	334	371
50 "	.....	.....	.....	.....	.....	.....	.....	.....	.....	310	344	382

The type of silo that has come into general and successful use in the semi-arid sections, and on high locations, is the pit silo. In areas where the ground water line is high, and where seepage water is likely to interfere, the pit silo is not practicable.

Among the advantages of the pit silo, the first is cheapness. It can be made with home labor. Aside from the

labor involved, there is a required cash outlay of only about forty dollars. Secondly, the pit silo prevents frozen silage entirely. Thirdly, it does not dry out or blow down when empty.

Among the disadvantages of this type, the first is that considerable labor is involved in getting the silage out. This is not of sufficient weight to be considered a drawback. The first 12 feet of silage can be thrown out by the use of a pitchfork. The remainder has to be hoisted out. For a small herd the silage may be carried out in baskets; for a large herd a hoisting device should be used. This latter may consist of a block and tackle, with the rope fastened to the top part of the silo cover directly above the center of the silo. A box of suitable size is fastened to the hook of the tackle. The hoisting may be done by hand or by a windlass fastened to the side of the covering, or by the use of a horse. Second, carbonic acid gas is likely to accumulate in a pit silo and thus render it dangerous. The time when a pit silo is dangerous is when it is being filled and is partly full. At this time precautions should be exercised. The air in the partly filled silo should be stirred up before anyone enters it. A candle may be lowered to test whether there is enough oxygen left to burn. If the silo has been filled and the silage is removed daily, there is very little danger in connection with an excess of carbonic acid gas.

Water for the Dairy Cow

The dairy cow needs a larger amount of water than probably any other domestic animal. The amount she drinks daily will vary according to the size, according to the milk she gives, according to the temperature and humidity of surroundings, according to the amount of exercise, according to the degree of dryness of the feed consumed, and according to the amount of protein consumed in relation to other nutrients.

The chief functions of water in a dairy cow's ration may be said to be as follows:

1. Water dissolves nutrients. No foods can be utilized by the system of the cow until they have been brought into complete solution. In accomplishing this, water plays an important part. The more food consumed, the more water a cow requires.

2. Water is a medium for distributing the food to the different parts of the body. Water may serve both as a direct and as an indirect transferring agency. For instance, when food is masticated, saliva is mixed with it. Saliva contains about 90 percent of water. Again, water when mixed with food in the digestive tract serves as a direct medium for transferring food.

3. Water is used as a vehicle for transferring waste and poisonous products from the system. This process of elimination is carried on through the skin, through the kidneys, through the digestive tract, and through the respiratory organs. In all of these instances, water plays an important part. In an animal such as the dairy cow, that consumes a relatively large amount of protein, water is of special importance. Urea is one of the soluble poisonous products resulting from a heavy protein ration. With the aid of water and proper circulation, the kidneys are able to rid the system of this particular substance.

During the winter, under average barn conditions, about 12 percent of the total water drunk by the cow is eliminated through the skin. During the summer about 27 percent of the water drunk is eliminated through the skin. About 13 percent of the water drunk in the winter passes through the kidneys in the form of urine. A little more than half, or about 56 percent of the water drunk, is eliminated in the feces. All of the excretory agencies need a constant water supply to perform their work of eliminating waste and poisonous matter from the body.*

4. A dairy cow uses water for the manufacture of milk. This latter product contains about 87 percent of water. In

* Bulletin No. 175, "The Role of Water in a Dairy Cow's Ration," South Dakota station.

the experiments conducted at the South Dakota station, the average cows in the experiment used about 15 percent of the water drunk for milk purposes. This percentage and distribution of water in the system of the cow vary according to the amount of milk given.

The portion of the water drunk by the cow eliminated through the urine, through the skin, and used for milk production, evidently must first enter into the circulation of the cow. The water in the feces probably never serves the system of the cow except as a food solvent, as a transferring medium, and for regulating the consistency of the



FIG. 74—A stream of pure running water is a great asset to a herd of dairy cows in pasture.

contents of the digestive tract. This does not refer to the water that may enter the digestive tract in connection with secretory or excretory products.

The sources of the water for a cow are as follows: 1. The water that she drinks, which constitutes the largest percentage. 2. The water that is present in all foods, even the dry hay and grain containing at least 10 percent of water, and the succulent feeds much more. 3. The water that results from metabolism within the cow. According to investigations by Dr. Babcock of the Wisconsin station, metabolic water results to the extent of 55.5 percent of the cellulose or starch, 60 percent of the dextrose, a little less

than 100 percent of the fat, and 60 to 65 percent of the protein digested. In accordance with this, the average cow is supplied with about one gallon of metabolic water daily. Cows in an experiment at the South Dakota station drank about 75 pounds of water daily, obtained about 19.2 pounds from the feed consumed—17.5 from silage and 0.7 pound from the grain, one pound from the hay—and about eight pounds of metabolic water. The total water then used daily on an average by each of these cows was 102 pounds. The cows in the experiment were just common cows, producing about two gallons of milk daily.



FIG. 75—In the semi-arid sections dams are constructed to hold water for the dairy herd.

5. Water regulates the body temperature. That there is evaporation from the body, as well as from breathing, is evident from what has already been said. During hot weather the evaporation of water from the body is about twice as great as in cold weather. The rate of respiration is undoubtedly also greater during the summer. The greater the evaporation of moisture from the body, the greater the amount of heat removed from the body.

Considering, then, the important functions of water, it is clear that a dairy cow should be supplied with plenty of fresh, pure water at all times, or be watered at least twice per day.

According to recent investigations, it appears that the water should not be given immediately before or immediately after the cow has eaten a heavy feed. An excess of water at these times may interfere with the proper digestion, especially of the crude fiber. Stale and putrid water should not be allowed the dairy cow. Water of this quality is not at all uncommon in some pastures during the latter part of the summer. When such water is drunk, the milk becomes tainted; besides, cows standing around in such water are likely to get their udders soiled. Through this medium the milk is likely to become infected with abnormal and harmful bacteria. Milk from such cows is also likely to contain filth.

The question has often been raised, "Can disease-producing germs be transmitted to the milk from the water the cow drinks?" It is generally admitted that germs cannot pass from the digestive tract through the absorption system and through the circulation to the mammary gland of a healthy cow. On the other hand, disease-producing germs in a cow's drinking water may infect the milk by direct means. They may get into the milk from the outside of the cow's udder, or from utensils that have been rinsed in this impure water.

For some time it was generally believed that alkali water drunk by dairy cows produced what was known as "alkali disease." Experiments have conclusively shown that this disease cannot be produced by feeding strong alkali water. In addition, it was found that cows may become accustomed to the use of alkali water which ordinarily is considered too strong to drink.*

The drinking water for a dairy cow has often been neglected. Some cows are forced to drink ice-cold water. Many milch cows have been turned out on very cold days and forced to sip the ice-cold water from between particles of ice. Ice-cold water in the stomach, and a temperature of perhaps 20 to 30 degrees below zero surrounding their

* South Dakota station Bulletins No. 132 and 147.

bodies, certainly impose a great tax on a dairy cow. Much heat is necessary to warm this water, and to maintain normal body temperature amid such surroundings. The source of this heat is in the feed.

1 pound of corn contains about 1300 calories of heat.

1 calorie equals the heat necessary to raise 1 kilogram of water 1°C . or 1 pound of water 4°F .

1300 calories, therefore, will heat 1300 pounds of water 4°F .

1300 calories will raise 5200 pounds of water 1°F . (1300×4).

1300 calories, or 1 pound of corn, will heat 74 pounds of water from 32°F . to 102°F ., or 70° ($5200 \div 4$).

The feeds digested by the cow cannot be entirely oxidized in the digestive tract of the cow. Therefore more than one pound of corn would be required to heat the water drunk daily by a cow from freezing point to body temperature.

According to King of the Wisconsin station, the heat in one pound of beef fat is required every 3.8 days to warm the drinking water to body temperature; if the water is warmed to 70 degrees, the heat in one pound of beef fat will heat the water 7.4 days to body temperature, or practically twice as long a time.

It is wrong to use dairy cows for stoves to heat drinking water and cold air, and to use expensive feeds for fuel. The water for the dairy cow should at least not be ice-cold. The temperature should be raised to about 60 degrees. A tank heater is desirable for this purpose, of which there are many forms. If a small boiler is used in the dairy, a steam pipe extended to the water tank is an easy way of taking the chill out of the water.

Neither should a herd of good dairy cows be compelled to go out on cold and frosty days to be watered. Arrangements should be made to water cows inside. Some use the individual trough in front of each stanchion. By this system, the cows have water before them constantly. In many barns, however, the water in the troughs and pipes would

freeze. Furthermore, dust and particles of feed are likely to settle into these individual drinking fountains, and in addition they are an extra expense.

A continuous concrete manger having a drain at one end has proven to be a successful method of supplying water for the herd. Some have

objected to this system on the ground that it was not sanitary, on account of the water running from one cow to the other. Yet this is the system the author has used during the winters for many years, and he can find no valid fault with it.

Some dairy farmers have constructed a water tank inside of the barn and the cows are let loose, a couple at the time, twice a day, to be watered.

For supplying water in the pasture during the summer good running water is the best.



FIG. 76—A water system on the dairy farm supplies water conveniently to the dairy herd. It also affords fire protection.

Cows should not be compelled to walk too far for the water in hot weather. A self-adjusting running windmill and a good well in the pasture will also take care of the water supply for the herd.

Cows should never be permitted to crowd each other around the water tank. This is not an uncommon cause of abortion in cows.

CHAPTER X

AMOUNT TO FEED THE DAIRY HERD

The average dairy cow should have all she can eat of one of the rough feeds. The amount of concentrates should be regulated. The nutrients in the form of rough feeds are less expensive than are the nutrients in the concentrates.

The amount of a given feed that a cow will eat is, of course, limited. It is limited first by the capacity of the cow, which varies with different individuals; and secondly, by the palatability of the different feeds. There can be no question but that there is a relation between palatability and digestibility of foods.

A dairy cow from which economic production is desired should always have feeds that are in good condition. Feeds that have been damaged during harvesting by rain, by too much sun exposure, or by being allowed to overripen, or that have become musty in storage, or that have been picked over by rodents, are not suitable for a dairy cow.

Amount of roughage.—From the standpoint of profitable milk production, a dairy cow should receive as much rough feed as she can handle. The nutrients in the form of alfalfa hay and silage are under most conditions much the cheapest. This is especially true in the central Northwest.

Some cows have a greater capacity for utilizing nutrients in this form, while others can handle nutrients best in the form of concentrates. Some rough feed or bulk is important for all dairy cows and all ruminants. The amount of dry matter that there should be in a dairy cow's ration usually varies between 20 to 30 pounds, 25 pounds being about the average.

When a cow is not giving more than about two gallons of milk daily, and if she is a capacious cow, she can consume

all of the required nutrients in the form of silage and alfalfa or clover hay.

From the standpoint of maximum production, without considering the cost of the ration, the individual cow must be studied more closely. A large producing cow, expected to make a maximum record, should have most of the nutrients in the form of concentrates. Some large producing cows, if fed large quantities of silage and hay, will not be able to consume and digest enough nutrients. Some cows will do better if the concentrates are increased and the amount of rough feeds is limited.

The dairy farmer should make it a point to raise his own rough feeds, and especially to raise alfalfa and clover hay to supply the protein. The following statements, based on yields on the South Dakota state college dairy farm, are intended to show the comparative amount of digestive nutrients that can be raised on an acre of land from some of the different crops.

TABLE SHOWING COMPARATIVE YIELD OF COMMON FEED CROPS.

Crop	Yield per acre	Percent digestible nutrients	Pounds of digestible nutrients on one acre
Corn silage.....	12.0 tons	.17	4012
Alfalfa hay.....	3.8 "	.51	3876
Oats.....	60.0 bu.	.70	1344
Barley.....	42.0 "	.79	1592

Cows fed relatively heavily on rough feeds seem to last longer. Their organs of digestion are not easily impaired. Cows that have been crowded for any length of time with grain, especially when feeding a narrow ration or a ration rich in protein, are likely to be useful for only a limited time. The continued heavy feeding of a protein ration seems to injure the procreative organs, and they are likely to become non-breeders.

This barrenness in heavily fed cows has been due in some instances to not mating them until after they are eight and even 10 months along in the lactation period. This latter is done to obtain maximum production in yearly and longer tests.

If a heavy grain ration is fed to a cow for any length of time, special efforts should be made not to have it too compact. Ground corn alone is considered a very compact feed. Feeds that have the consistency of flour, such as cottonseed meal, are also difficult to digest. Ground oats and barley are of medium compactness, and a mixture of bran and ground oats constitutes a light and fluffy grain ration. A certain amount of bulk is important in both grain and roughage.

Amount of concentrates.—It is especially in connection with feeding grain that both skill and economy need be exercised.

Some cows are well balanced and their ability to handle feed corresponds with their natural ability to transform it into milk.

Other cows have greater ability to consume and handle feeds, but very little ability to convert them into milk.

Still other cows again have dainty appetites and little ability to consume feeds, but have an unusual ability for converting whatever feeds they do consume into dairy products.

The cows belonging to the first-mentioned class are relatively easy to feed. Those of the second class may easily be fed grain without obtaining proper returns. The cows of the third class usually make good returns, but considerable skill is required in making up a ration to get them to eat as much as they can convert into milk. Such a cow usually does not put on much flesh.

The balanced cow, or the one belonging to the first-mentioned class, is the kind that every dairy farmer likes to develop and likes to feed. The feeder should watch the milk produced in relation to the amount of grain fed. The grain ration should be gradually increased. So long as the increase in milk production is sufficient to pay for the increased amount of grain, the dairy farmer is safe in continuing to increase the cow's grain ration.

The limit of the cow's ability to convert this feed into milk will soon be reached. When this occurs, it is important that the grain ration be no longer increased. If it is, then the cow may put it on herself in increased weight, or she may not make use of it at all, or it may injure the cow's health, and make her stale. If this happens, then she loses her appetite. She has been overfed.

The point where a cow will no longer return sufficient milk to pay for the increased feed is usually reached when she is getting one pound of grain for each three or four pounds of milk produced, or when she is fed as many pounds of grain daily as she produces pounds of butter fat per week.

With the average dairy herd, there is greater danger of loss from underfeeding than there is from overfeeding. This point may be illustrated in this manner. Suppose that a cow is on full feed. Forty percent of this feed is used for body maintenance and 60 percent for milk. This cow is at her maximum. Now again, suppose that this ration is reduced by 10 percent. This decrease of feed will make itself felt chiefly in less milk, but also in a reduction of body weight. The instinct for milk production in a cow is so strong that for a time she will draw from her own body for milk production. If this decreased ration continues, the cow will soon reach a point where there is no more body surplus from which to draw. Then the amount of milk yielded will be decreased about 10 percent, or the same percentage by which the feed was reduced.

The amount of grain each cow receives should be definitely known. This grain may be weighed separately, or a mixture of grain may be made and then weighed and measured out for each cow. When a number of different grains are fed and there is a large herd, the former method is too slow. A basic mixture of grain can be fed to all of the cows. The few large producing cows needing an increased amount of special grains may then easily be fed them in addition. A good basic mixture to feed the average dairy herd receiving

corn silage and alfalfa hay or clover hay as rough feed, is as follows:

Ground corn -----	25 percent
Ground oats -----	55 "
Wheat bran -----	20 "

For large producing cows add about two to four pounds of linseed meal per day.

For cows receiving corn silage and prairie hay, or broom grass hay, or timothy hay for roughage, the following basic grain ration is suitable:

Ground oats -----	45 percent
Ground barley or spelt -----	20 "
Wheat bran -----	20 "
Linseed meal -----	15 "

The feeder must mix his grain ration to suit the cow and the conditions, always keeping in mind these points: 1. Sufficient nutrients of the right kind. 2. Proper bulk and consistency. 3. Variety. 4. Physical effects of the ration. 5. Cost of nutrients in the different feeds. 6. Palatability.

Grinding grain.—The grain when fed should be in the best possible condition to be masticated and digested by the cow. The teeth and the stomach are usually the first organs to be worn out by a dairy cow. This is especially true of a cow's teeth. Grinding the grain for a dairy cow saves the teeth and the stomach. With a steer that is to be marketed when about three years of age, this consideration does not apply so much; neither does it apply to a young calf that changes his teeth.

Much energy is required for grinding the feed. This is true whether it is done by the cow or by a grinding machine. The latter is by far the cheapest and also most efficient apparatus for grinding grain. The extra amount of energy required for masticating unground grain should be turned into milk or into useful body purposes.

In addition, much waste results from feeding a dairy cow whole grain. As much as 24 percent of the whole grain fed to a cow may pass through the digestive tract unmasticated

and undigested. In connection with cattle feeding, hogs pick up this waste, but hogs should not be allowed to follow up a herd of dairy cows. Calves have great ability to masticate and digest whole grain. The author has never observed whole grain pass through the digestive tract of calves.

Occasionally the corn in the silage will pass through the digestive tract of a cow without being masticated or digested. This is one reason why the corn should not be allowed to overripen or become hard before the silage corn is harvested. This passing of whole grain through a cow is also more frequent when there is a large proportion of kernels to stalk in the silage.

Variety.—It is possible to obtain a balanced ration for a cow from alfalfa hay and corn. This would be a simple ration to feed, but it lacks variety. Several different kinds of grain blend together better in the process of digestion. Cows like a variety better than a ration composed of a single kind of grain, and attractiveness of a ration for a cow is important.

It is also possible that some grains may contain substances which, when mixed with substances in other feeds, are desirable. It has been amply proven that the ordinary composition of grain (protein, carbohydrates, fats, minerals) does not tell the whole story in connection with the constituents of feeds. It has already been shown that there are several kinds of proteins and that the crude protein in a certain feed is made up of several nitrogenous bodies. Likewise the ether extract, carbohydrates, and fats in the different feeds may differ greatly. Decomposition and synthetic changes in the digestive tract may proceed more favorably when a variety of feeds is given.

Order of feeding.—In European dairy countries the order and time of winter feeding are regular. For instance, in Denmark the feeding starts early in the morning, or when the milking begins. Usually the cows are first fed rye straw, then barley straw, and then oats straw. In the rote-

tion of crops, clover is usually seeded with oats. This makes the oats straw contain considerable clover, a combination liked by the cows. When these straws have been eaten, the mangers are cleaned and the excess straw, if any, is used for bedding. Then the cows are fed some of the chaff from the threshing of the different crops. The grain is weighed out for each cow and usually put on the top of the chaff. When this is eaten, the mangers are thoroughly cleaned and the cows are watered (usually from the mangers). The excess of water is drained away. At this point the roots are usually fed. The cows are then fed hay. While the cows are eating hay they are usually curried. Then the various alleys are swept and the bedding under each cow is adjusted. All of this is usually completed by about 10 o'clock in the forenoon.

The cows are then allowed to rest until about two o'clock in the afternoon. Where the milking is done three times a day, the cows are disturbed long enough to be milked at noon.

Beginning about two o'clock in the afternoon, this same order of feeding is again started, except that the rye straw is omitted as the first feed, and usually is given the last thing in the evening after milking, which is about eight o'clock at night.

This system cannot well be followed under conditions in the United States. Labor is more expensive and feeding must be done in the simplest way possible. It is, nevertheless, important that winter feeding of a herd of dairy cows be carried out with regularity. The method followed must be governed by local conditions and cannot be prescribed.

The method followed by the author is as follows: Beginning in the morning, push the excess hay left in the feeding alley up close to the cows. This can be done without stirring up any dust. The milking is then done while the cows are munching on this hay. Then the cows are fed their silage and the grain on top of it. The cows are resting and

digesting this feed while the men obtain their breakfast. Then the mangers are swept and the cows are watered. A liberal amount of hay is then fed.

In cold and stormy weather the cows are kept in the barn all day. In reasonably favorable weather the cows are let out in a yard sheltered by means of a shed opening to the south, having a manger in front. This manger always has plenty of hay in it. In addition, a large hayrack in the yard is kept filled with hay.

While the cows are out during the middle of the day, the silage and the grain on top of it are put into the manger. The cows are let in about three o'clock in the afternoon. When the cows are in place, the alleys are swept and doors and windows opened to eliminate silage odors and dust that may be in the barn. The milking in the afternoon begins about 4.30 o'clock. Nothing is fed during the milking period or just previous. Just after milking, the cows are given plenty of hay for the night. In case the cows are not let out in the yard during the day, they are watered the second time just before they are fed silage and grain.

Some herdsmen having cows on large production tests make it a habit to feed the cows each time they are being milked. When cows get into this habit, they naturally expect their feed when the milking is done. It is, however, not necessary and probably not important thus to feed a cow when she is being milked. This is probably done largely for convenience. Such a cow is usually milked four times a day and these milking periods naturally constitute convenient times for feeding. The point to be emphasized is to practice regularity of feeding and to feed the feeds about in the same order daily. A cow should not be fed grain early in the morning one day and late the next day.

Cost of Ration

There are some qualities of feeds on which a money value

cannot well be set. For instance, the author has practiced feeding some linseed meal daily to all large producing cows, no matter what the cost has been. This was done on account of favorable physical effects of this feed.

The condition of the feed and the palatability of it are other factors on which no definite money value can be given. Nevertheless, they are factors of importance and factors that influence the value of a particular feed.

The comparative value of the different feeds in respect to the amount of digestible nutrients, or in respect to the amount of protein and net energy may be calculated.

Example: A dairy farmer feeds alfalfa hay and silage for roughages, and for concentrates he has on hand plenty of corn, barley, and oats—in fact, so much on hand that it is necessary to sell some. Suppose that the price of corn is 86 cents per bushel. The problem for such a dairy farmer will be, which of these grains should be sold and which should be fed to the cows? Calculated according to the digestible nutrients, the comparative value would be as follows:

100 pounds of corn contains:

(\$1.45 per 100 pounds)		
Protein	7.5	} nutritive value per pound. $\$1.45 \div 85.7 = 1.70$ cents
Carbohydrates	67.8	
Fat ($4.6 \times 2\frac{1}{2}$)	10.4	
Total nutrients	85.7	

100 pounds of barley contains:

(\$1.25 per 100 pounds)		
Protein	7.5	} nutritive value per pound. $\$1.25 \div 79.4 = 1.57$ cents
Carbohydrates	66.8	
Fat ($4.6 \times 2\frac{1}{2}$)	3.6	
Total nutrients	79.4	

100 pounds of oats contains:

(\$1.25 per 100 pounds)		
Protein	9.7	} nutritive value per pound. $\$1.25 \div 70.4 = 1.77$ cents
Carbohydrates	52.1	
Fat ($3.8 \times 2\frac{1}{2}$)	8.6	
Total nutrients	70.4	

It will be seen from the above that one pound of digestible nutrients in the corn is worth 1.7 cents, in the barley 1.57 cents and in the oats 1.77 cents. From the standpoint of contained nutrients, this would make the barley the cheapest feed, the corn the second cheapest, and oats the most expensive.

Considering that corn and oats are very nearly equal in value from the standpoint of nutrients contained, and considering that oats is such a splendid feed for a dairy cow, it would probably be advisable to retain the oats and corn and dispose of the barley. There is something about oats as a feed that gives life and bloom to an animal which a feed like corn does not possess.

If a person had prairie hay for roughage instead of alfalfa hay, then it would be a question largely of purchasing protein in the cheapest form in order to balance the ration. The comparative value of protein in these different feeds may be calculated in the same manner as illustrated above with the digestible nutrients. That is, the value per 100 pounds of feed may be divided by the percentage of digestible protein. The quotient would represent the comparative price per pound of protein of the different feeds.

According to the above method, the value of 100 pounds of digestible nutrients in the form of hay and other rough feeds will be found to be relatively too low. A pound of digestible nutrients in the form of rough feed does not contain so much net energy as does a pound of digestible nutrients in the form of concentrates fed in proper form. The cow must expend considerably more energy in masticating and digesting rough feeds than in preparing the concentrates for absorption by the system.

The comparative food value of the different feeds may also be calculated by using the Armsby data, for instance, with the same feeds and prices used above, corn at \$1.45 per 100 pounds, barley at \$1.25 per 100, and oats at \$1.25 per 100.

100 pounds of corn contains	89.16	therms	$\$1.45 \div 89.16 = 1.62$	cents per therm
100 " " barley "	89.94	"	$\$1.25 \div 89.94 = 1.39$	" " "
100 " " oats "	67.56	"	$\$1.25 \div 67.56 = 1.85$	" " "

By this method it will be seen that the same relative values of these feeds are obtained as when calculated on the basis of total digestible nutrients.

The total digestible nutrients in feeds furnish probably the most accurate value of different feeds. At least this appears correct so long as the Armsby net energy determinations of all the feeds have not been completed.

Feeding for maximum records.—When a maximum production from a dairy cow is expected, no emphasis is laid on the cost of the ration and on the amount and cost of the labor. It is not a case of economic production so much as of maximum production.

The things mentioned previously in connection with feeding the dairy cow need to be emphasized to a still greater extent. The variety of grains fed is usually greater in number, and greater care is used in selecting the most palatable feeds. The palatability of the ration is of special importance when a cow is on heavy feed. Her appetite is not usually so keen. In order to find out which feeds such a cow likes best, the author provides a long feed box with several compartments in it. At first, when the cow is put on the heavy feed, the different grains are fed in this box separately. By watching the cow, one can soon learn which feeds she likes best and which feeds have little or no attraction for her. It is usually safe to make up the ration chiefly from the feeds which she craves the most.

Cows on production tests are usually fed the salt in the grain. Dr. Babcock's rule is to feed an ounce of salt to each 20 pounds of milk produced, and in addition an ounce for each 1000 pounds of live weight. In addition to this, the cows should have free access to salt at all times, and free access to pure, clean water.

The author also practices feeding two kinds of hay. Well-cured alfalfa hay and wild hay both are kept before the cow.

If silage is fed, it should not be given in large quantities, usually not over 30 pounds per day; but it is important that the cow receive a good heavy ration of some kind of roots, sliced for the convenience of the cow, if the silage is considerably lessened.

It will be noticed that the feed provided is to obtain the maximum normal production. Some cow owners do not feed cows on test a full ration. This is claimed to produce a higher percent of fat in the milk; that is, more of the body fat goes into the milk when the cow is compelled to draw upon her own body. However, by this system the milk yield is usually low.

A cow on official test may be kept in a well-bedded box stall. Hot weather is a poor time in which to make a large official record. Spring and fall are usually the most suitable.

A cow on such heavy feed should be very carefully watched. The caretaker should see that the bowel movement is regular and of proper consistency.

The cow's appetite must be kept keen at all times during the test. If the cow should become constipated and stale, reduce the grain ration at once and give the cow a rectal injection. A mild laxative should also be given. This may consist of a pint of raw linseed oil or a pound of epsom salts, dissolved in a pint of water. Great care should be taken when drenches are given that they do not settle on the lungs.

CHAPTER XI

MILKING THE DAIRY COW

Milking a cow requires good judgment, skill, and a sympathetic attitude on the part of the milker, and, above all, it requires a high regard for proper sanitation. In countries where dairying is carried on intensively, the process of milking is emphasized. For instance, in Denmark the different agricultural schools have given a special milking course, with a view of acquainting all milkers with the importance of skill, system, and the proper methods of procedure. Prizes are offered to those who qualify as the best milkers. This stimulates interest and those who thus excel as milkers are able to command a very high salary.

Condition of Cow

The Structure of a Cow's Udder.—A cow's udder is divided into two halves longitudinally. The left and right halves are entirely separated by a membrane which attaches to the twist behind and on the lower part of the abdomen in front of the udder. This serves as a complete partition between the right and left halves, and in addition helps to carry and support the cow's udder.

Each one of these halves is again partially divided into a front and hind quarter.

The mammary gland is a secretory gland. Milk is secreted in a manner similar to the secretion of the saliva in the mouth and of the gastric and pancreatic juices in the digestive tract. The raw material is carried by the blood to the mammary gland. This gland manufactures these raw products into milk. The mammary gland is located in the upper part of the cow's udder. It is composed of an aggregation of little sack-like bodies. Each of these sack-like bodies has a duct leading from it. These numerous

small ducts join together and form larger ducts, which terminate in the lower part of the cow's udder in what is known as the milk cistern. The above-mentioned sack-like bodies are known as gland-lobules. Some call them ultimate follicles. On the inside of these gland-lobules are a number of still smaller bodies, which are known as alveoli. The alveoli constitute the real machinery for the manufacture of the milk. The gland in each quarter of a cow's udder has been likened to an inverted cluster of grapes. The stems leading to the grapes are likened to the milk ducts, the grapes or the fruits to the gland-lobules, and the seeds of the grapes to the alveoli.

At each place where these ducts branch and rebranch, there is a muscle over which the cow has complete control. She can open and close them at will. It is a well-known fact that some cows, under excitement or because of some other provocation, will hold up their milk. For a schematic cross-sectional view of a cow's udder, see figure 81.

Clean and Healthy Cows.—Considering that the natural ability of a cow to produce milk has been much increased, and since a high-producing cow is a specially developed being, one might expect more or less trouble in keeping the cow's udder in perfect condition at all times. If this secretory organ becomes abnormal in any way, it stands to reason that the milk will not be normal. It is the business of the milker to watch carefully that normal milk is at all times produced. In case of any unhealthy condition of the cow the milk should not be used.

As has been previously stated, certain feeds, such as wild onion, garlic, or decayed food of any kind, will taint the milk. Such tainted milk is not the result of any malady of the cow's udder. The purity of a cow's milk is naturally well guarded. Nature intended to protect in every way possible this natural food supply. Digestive derangements, if prolonged, will cause milk of abnormal quality. Some cows' milk is abnormal during the œstrual period.

The milker should be careful that the cow herself is clean

at the time of milking. Clean milk cannot be produced from cows that are covered with manure on the sides and thighs. If a cow's udder and teats are soiled, and if her sides and thighs are dirty, she must be cleaned before milking. Ordinarily, wiping the sides and udder with a damp cloth is sufficient. This cloth may be moistened occasionally in a disinfectant solution. In case that the cow's udder is very soiled, it should be washed with a cloth in lukewarm water and dried before milking.

Dirt that falls from the cow into the milk causes trouble in two ways. First, it imparts a bad cowy flavor to the milk, and, secondly, there are many undesirable germs that accompany the dirt. These germs or bacteria multiply and develop in the milk and cream and produce foul smelling gases and other undesirable by-products.



FIG. 77—A concrete sanitary and sheltered cow yard.
(Universal Portland Cement Co.)

Clean healthy cows fed on good wholesome feeds are requisites to sanitary milk production.

Keep Cow's Teats in Good Condition.—Chapped teats are quite common. This at times comes about from frequent washing in hard cold water without properly drying afterwards. It may also result from the cow's wading about in ponds of stagnant water. Use warm soft water

with a little disinfectant in it, for washing cow's udder and teats, and afterwards carefully dry them with a clean linen cloth. When they have been carefully dried apply a little vaseline or a salve which has been made up from three parts of lard and one part of turpentine. The latter is desirable for sore teats of all kinds.

Sore teats from barb wire cuts is another common ailment. This trouble is not common on farms where woven wire fences are used and where cattle are not pastured much. Such a wound usually heals very slowly. This is due to the fact that every time the cow is milked, the wound is usually reopened. The milker should make a special effort to allow the healing to continue. Mechanical milking is much easier on such a cow than is hand milking. When such a wound is cut, it should at once be thoroughly washed out with a disinfectant. Then apply a salve. One of the ordinary carbolic acid salves, vaseline, and the turpentine salve, described above, are all suitable. The writer has seen ordinary lubricating oil and ordinary axle grease used with success. They keep the germs and dirt away and protect the open sore from coming in direct contact with the air.

In some instances the cut is so deep as to cause the milk to flow through on the side of the teat. The raw wound may be healed, but it is difficult to get the parts to grow together so as to close the opening entirely while the cow is giving milk. If the cow does not give much milk, it is best to dry her up. In case that she cannot be dried up before the wound heals, the sore may be repaired after the cow dries up. This is done by recutting the skin next to the opening. A sterile milking tube is inserted through the regular canal of the teat. Then put rubber bands around the wound and teat just tight enough to hold the wound together. Be sure that the wound is thoroughly disinfected before the rubber bands draw it together. In a short time the opening will close together completely. Then the milking tube may be taken out. Leave the rubber bands on till

the wound has completely grown together and there is no more danger of its separating.

The most serious and most painful teat wounds result from a cow's stepping on her own teats. This happens with cows having pendulous udders and long teats. It usually happens when a cow gets up in her stall after having laid down.

At times one cow will step on another cow's teats. This usually occurs in the stall, especially where cows are crowded closely together in the barn.

When cows are thus crowded closely together and where there is no post or partition of any kind between the cows they are likely to injure each other's udders seriously. When cows are lying down in their stalls with their feet towards each other, one or both may stretch and push the hind feet against the udder of the cow lying next to her. A post or partition coming within a foot of the gutter prevents this danger.

Cow pox is another common cause of sore teats. This is contagious. The disease shows itself in numerous little water blisters on different parts of the teat. The disease is not serious, but causes considerable inconvenience to the milker and to the cow. The disease usually has to run its course. It lasts about ten days. The milker should be very careful not to carry the disease from one cow to another. He should carefully wash his hands in a disinfectant solution after milking affected cows. It is also a good plan to milk such cows last.

The cow should be milked gently, so as not to rupture the little blisters until skin has formed underneath and they dry up of their own accord. Apply freely the vaseline or the turpentine and lard salve mentioned above.

Sore teats at times result from internal growths. Little lumps are formed on one side of the canal or opening in the teat. These at times may become so serious as to completely obstruct the passage of the milk. If the trouble is not removed, the quarter itself will soon become swollen

and sore. Sometimes such growths in the center of the teat are very difficult to handle. About the best way to treat such a cow is to disinfect thoroughly a milking tube and insert it into the teat. Allow the tube to remain until the growth has ceased, and even until it has disappeared, when the milking tube may be removed. The use of a teat slitter or bistoury is not advisable except in case of necessity. Making an open wound internally simply makes additional trouble.

Another cause of sore teats is warts. These are especially troublesome if they are large and numerous. A good way to eliminate long warts is to take a thread soaked in a sterile solution and wrap it tightly around the base of the wart. In a short time the wart drops off. When this happens, the sore is entirely healed. The wart may be clipped off with a pair of sharp scissors, but this leaves a very tender sore on the teat. In case an open sore results, always apply a disinfectant and cover the wound with a salve.

Hard milking cows are objected to by most milkers. To some extent this condition may be improved by inserting a teat expander in the end of the teat. The same thing may be accomplished with a small smooth wooden plug crowded into the end of the teat and made to stretch the sphincter muscle. Whatever is inserted should be very thoroughly sterilized first. If the cow is not a desirable dairy animal, it is advisable to eliminate her from the herd. At least, it is not a good plan to perpetuate her blood and raise her heifer calves for future cows.

At times and immediately after freshening, the opening of the teat is clogged. This is not serious, and may be remedied by inserting a sterile silver milk tube. Usually this trouble is only temporary. It is due to some gelatinous substance that has dried at the opening of the teat.

On the other hand, there are some cows that are so easy to milk that the milk leaks away between milkings, or it begins to run away as soon as milking time approaches.

Such cows should be milked first. There is no known permanent remedy. It is a natural condition resulting from the sphincter muscle, at the end of the teat, being loosely drawn. Occasionally this condition results from cows having had the end of one or more teats injured. A little collodion applied to the opening immediately after milking may prevent the leakage.

Swollen udders.—At the time of freshening nearly all udders are swollen more or less. This is natural and to be expected. This natural swelling at the time of freshening usually disappears in a few days. A cow should not be fed too heavily on grain at this time, and should not be permitted to lie down on cold, damp ground.

The common and troublesome swelling of a cow's udder is due to garget or mammites. It is a disease and is contagious. A streptococcic type of bacteria is the cause. The garget may attack the whole udder of a cow, but usually one quarter is affected at a time. The affected portion of the udder becomes swollen, very hard, and feverish.

A gargety udder is very tender, and the milker should use patience and care. The milk at such a time is usually stringy, and it may be bloody. Such milk should be discarded.

A cow in this condition should be milked out several times a day. After each milking make a hot application of some kind. During fall and spring when the flies do not trouble, the warm milk from the cow may be applied and the udder bathed thoroughly in it. Hot water, containing considerable salt so as to form a strong brine, may also be applied as hot as the cow can stand it. The care taker should not be in a hurry, even if the process lasts 10 or 15 minutes. After the affected portion of the udder has been thoroughly soaked, then with a dry linen cloth carefully and gently rub it dry. Then apply salve made up as follows:

2 parts of melted lard.

1 part spirits of turpentine.

1 part fluid extract of belladonna.

Another good salve that is highly recommended is made up of :

- 1 part fluid extract of pokeroot.
- 1 part fluid extract of belladonna leaves.
- 6 parts lard or sweet oil.

In most serious cases it may be necessary to apply a hot poultice. This may be made up of bread and milk. The best kind of a poultice to apply is made up of antiphlegestine, or from any of the pastes made up chiefly of kaoline. Before the latter poultice is applied, clip off all hairs from the cow's udder, then warm the antiphlegistine and put it on a cloth. The whole is bandaged against the affected part of the udder. The cow with a large swollen udder should always have an udder support on her. It may be made from a piece of good cloth or may be purchased already made.

A cow having a serious case of garget should be given a good physic. From one pound to two pounds of epsom salts may be given her as a drench. Some recommend giving the cow affected with garget one ounce of saltpeter per day.

Catarrh of the udder is another common disease affecting cows. This usually affects the inside membrane of the milk ducts. It is difficult to cure. With some cows the disease is chronic in nature. Hot applications are the best known remedies.

Condition of Milker

Clean and healthful milker.—Usually too little precaution is taken in order to keep milkers clean and neat during milking. Under average farm conditions it is probably not practical to advise wearing white suits, but the person should at least have on clean overalls and clothing that is not worn while doing other kinds of work. When producing milk for direct human food the milker should wear a clean white suit.

The milker should have clean hands and be prepared in every way to keep the milk perfectly sanitary.

It is very important that the milker is healthy and especially that he does not have any of the common contagious diseases.

Manner of procedure.—The cow is usually milked from the right side; but cows may be accustomed to being milked from both sides. Where one milker has a large number of cows to be milked, it is not at all uncommon for a milker not to change position. That is, the milker gets in between two cows and stays there until both cows have been milked. This will necessitate milking one cow on the right side and the other one on the left. It is probably best, however, to make it a rule to milk all cows only from the right side.

The milker should at all times approach the cow gently. Do not in any way scare or make her nervous.

Frequently the two front quarters are milked first. This provides more room for milking the hind quarters. There are milkers who prefer to milk the whole half on the side of the milker first. There are times when leaving the hind quarters to the last, the unmilked portion of the udder becomes so distended and the teats so short that the milking is made much harder. The plan followed by most milkers is first to milk most of the milk from the teats that milk easiest. If the two front teats are easier to milk, then it is natural for the milker to empty them first. A portion of the milk from the hind quarter can in this manner be drawn through the front teats. Whatever method of procedure is followed, plan to make it uniform each time of milking.

The most common and probably best way is for the milker to hold the pail between the knees. There are now special milking stools, a portion of which is made to hold the pail. The rapid milker usually does not want to be bothered with any of the patent milking stools. A piece of board nailed horizontally on top of a vertical piece of two by two of proper height to suit the particular milker is usually the best kind of a stool. Some milkers strap these stools to the body so the milker never needs to take hold of it and never needs to handle the stool with the hands.

Dry hand milking vs. wet hand milking.—There are many milkers who claim that they could not milk at all if they had to milk with dry hands. This is a mistake. Wet hand milking is only a bad, insanitary habit. The author used to think that wetting the hands and teats was necessary to successful hand milking. Milking one winter in an open shed where the temperature often was 20 degrees below zero completely converted him to milking with dry hands. This is much more sanitary and just as convenient.

If one is so addicted to wet hand milking that he cannot quit, then keep a small supply of vaseline or turpentine salve on hand. A small pinch of this salve for each cow serves a much better purpose than wetting the hands with milk, and in addition, it helps to keep the teats in good condition.

Milking the cow clean.—It is important that no milk be left in the cow's udder after each milking. If the milker habitually leaves some milk, the cow is likely to go dry earlier than she otherwise would. Moreover, the last milk in the cow's udder is the richest. It contains as high as 10 to 12 percent of butter fat, while the first part milked contains only a fraction of a percent. The author knows of farmers who have advised the hired man to milk only as much as can be milked quickly. "Do not waste your time stripping the cows. Let the calves do that." Milking the cow by the combined efforts of the calf and the hired man is a very poor plan. One or the other should do it, and the owner should see that it is done well. So much milk may be left in the cow's udder that it will cause abnormal milk and diseased udders. The latter is a frequent result of indifferent and careless milking.

Condition of Utensils

Clean and sanitary utensils.—No one should use insanitary pails, cans, or separators. Everybody should have the desire to keep everything connected with human foods tidy and clean. The word "clean" does not have the same

meaning to everybody. What is clean to one person may be dirty to another.

We say that the barn is clean, yet we would hesitate to work in the barn with our best clothes on. We say that the floor is clean, yet if some food from the table should fall from the floor, we would hesitate to eat it. We say that our plates from which we eat our meals are clean, yet a surgeon would not lay his instruments on them without sterilizing them before an operation, fearing that some undesirable germs would be present. To produce clean milk and to keep it from spoiling, it is important that the pails, the cans, and other utensils be well cleaned and sterilized after each using.

All utensils should be washed with a stiff brush in warm water containing some washing powder. Do not use a rag. Then each part should be rinsed in boiling water. It is just as effective, even more so, to sterilize them over a jet of steam.

All milk should be strained through an efficient and sanitary strainer into a clean bright can.



FIG. 78—Bacterial growth from hair of cow. (T. H. Lund, Guelph Ag. College.)

If there is steam obtainable, all utensils should be steamed just before milking begins. Various experiments show that no matter how well the utensils have been cleaned, many germs or bacteria lodge on them between the cleaning and milking. Boiling hot water may take the place of steam. Rinse the utensils off in it thoroughly just before

milking begins. A milk pail having a small top or opening should always be used. This greatly reduces the number of

germs that enter the milk from barn dust and from the side and udder of the cow.

Kicking cows.—Usually when cows kick during milking there is some cause for it. Most heifers will kick more or less when first milked. This is natural and usually it is not a vicious kick. The prudent milker uses care and gentleness. After the heifer has been milked a few times and if the udder is not diseased, she soon learns that she is relieved each time and that it is to her benefit.

Occasionally cows are found that are chronic kickers. The simplest way to deal with such individuals is to dispose of them for the block at the opportune time. Until such a time the hind legs may be tied with a strap just above the hocks. There is an anti-kicking device on the market which works effectively. It consists of two wide iron hooks connected with a short chain. This chain may be lengthened and shortened to suit the individual cow. The two wide hooks fit on the hind legs just above the hock joints.

Sucking cows.—There are cows which suck themselves. Such a cow is not worth much for dairy purposes. It is usually not worth the trouble to provide means that will prevent sucking. If it is a valuable breeding animal, the self-sucking habit may be prevented by putting a halter on her, and a surcingle around her heart girth. Then tie a staff on her, reaching from the halter to the surcingle on the side of her body. Some use a halter having long sharp prongs extending out from the nose band. Others slit the tongue part way, and others put a bull ring in the nose and suspend a second one from this.

Trouble also results from individuals of the herd sucking each other. Recently weaned calves are usually the perpetrators. A halter having enough sharp prongs on the nose strap is usually sufficient to prevent this. If the habit continues, such animals should be kept separate, or else sold off from the herd entirely.

Milking previous to freshening.—Many dairy farmers

insist upon milking cows just previous to freshening. The udder many times becomes quite distended. This swelling of the udder is not always due to the presence of milk. Many times it is due to standing in a crowded stall and lying down on hard, cold surfaces. Repeatedly, the author has taken cows with such distended udders from the stall and put them into a well-bedded, roomy box stall, whereupon the swelling invariably goes down. Milking a cow will not help this kind of swelling very much. The owner or caretaker should be careful that the swelling is due to milk before any milking is done.

Generally speaking, a cow should not be milked before freshening. This first milk nature intended that the calf should have. Milking just previous to freshening is not normal, either for the cow or the calf.

There are instances where it is advisable to milk a cow before she freshens, but do not begin until it is necessary and until the cow shows signs of freshening within a short time.

The swelling of the cow's udder alone is not a definite indication that she is going to freshen. The surest indication that freshening time is approaching is when the muscles extending from the tail bone to the pin bone on each side of the tail head begin to loosen. When they loosen to such an extent that one can scarcely feel that there are muscles, then the cow will usually freshen within twelve hours.

Resting period for the cow.—From a practical as well as experimental standpoint, it has been demonstrated that a cow that has from four to six weeks' rest each year will do better than will a cow that milks continuously from one freshening to the other. A few insist on giving cows a longer resting period than this. Some of the breeders of pure-bred cattle who expect to make maximum production with the cows let them go dry a much longer time than this.

It is certain that when a cow milks clear up to the time of freshening she starts out afterwards at a much lower level of production. If she is given a rest she will more than

make up for the amount she lost during the period she was dry.

As previously mentioned, the cow should be well fed during this resting period, even though she is not giving any milk. It does not hurt to permit a cow to lay on flesh during this time. If she is the right kind of a dairy cow, she will milk it off after freshening. It has been demonstrated by many practical men, and substantiated experimentally by Prof. C. H. Eckles of the Missouri station, that shortly after freshening most cows produce a higher percentage of fat in the milk than they do later on. In other words, a cow in good condition will milk off her surplus flesh during the first few weeks and months after freshening.

It is also considered that this resting period enables the cow to nourish the calf, or fetus, better than if she were compelled to give milk also.

There are a few cows so persistent in milk production that it is difficult to dry them up. When the time comes to dry up a cow, take away her grain ration and give her only hay, wild hay or timothy hay. Milk her only once a day for about one week, then milk her only every other day, then only every three days. Do not use this milk from the latter milking. So long as the cow is milked once a day the milk is normal. When the cow gives only about 10 pounds of milk per day the milking can be omitted entirely. Watch the udder carefully and see that it does not harden and swell. When the cow is dried up, it may then be a good plan to milk out some of the abnormal milk in the udder. It does not hurt to leave milk in the cow's udder so long as the udder does not become diseased. The system will absorb what is therein. After the cow is dry, begin to give her some grain again.

Lengthening milking period.—The author is not prepared to say that the persistency of milk production may be increased by lengthening the lactation period of a cow. He has, however, observed that a cow may develop the habit of giving milk only a short time. It seems reasonable that if

a cow's milking period can be made habitually shorter, it may also be lengthened. The author makes a practice of not mating the heifers too early after the first freshening. He believes that a heifer should milk at least ten months the first lactation period.

It is difficult to prove this point experimentally, as no one can say definitely whether the results of such an experiment may not be due merely to the individuality of the animal.

Milk fever.—Milk fever is a disease which used to be dreaded very much. It usually attacks the largest producing cows in the herd. So far as known, it never attacks heifers. It is usually mature and aged cows that contract the disease.

Milk fever generally occurs the first few days after freshening, though the disease may occur several weeks after it. The author has known cows that had milk fever twice after freshening. The first signs of milk fever are usually partial paralysis of the limbs and a worried look in the eye of the cow. The cow trembles. She is unable to control her hind quarters. Finally she loses control of her muscles entirely and is unable to get up.

Milk fever used to be fatal in nearly every instance. Then Prof. Schmidt of Denmark discovered the potassium iodide method of treatment. This is said to have saved about 60 percent of the milk fever cases that were treated. Later Prof. Anderson, also from Denmark, discovered the air treatment for milk fever. This latter method consists of injecting sterile air into the cow's udder. Usually the cow is first milked out. Then with a special pump sterile air is pumped into the cow's udder until it is full and distended. Then a band is tied around the ends of the teats so the air does not escape. With hard milking cows this latter is not necessary. The udder is then gently massaged. In a few hours the cow usually recovers. The author has not experienced a single case where this treatment has failed to perfect a cure.

In the absence of the special pumps, an ordinary bicycle pump may be used. The author has used this several times with good success. An ordinary quill may be used as a connection between the pump and the cow's udder. By this method the air is not sterilized, and such air may cause infection of the cow's udder; hence it should be used only in cases of necessity.

Keep air in the cow's udder after she improves and is able to stand on her feet. It is well to pump up the udder two or three times. It is one of the simplest and surest remedies for an otherwise very serious disease.

To prevent milk fever, avoid feeding the cow heavily on grain immediately before and immediately after freshening. The flow of milk should be brought on gradually.

Some recommend not drawing all of the milk from the cow's udder immediately before and immediately after freshening. Milk out only about one-half of the milk at first, just enough to release the distended udder. Then next time draw out about three-fourths of the milk. It is claimed that this is nature's method and that a cow treated in this manner is not so likely to contract milk fever.

Handling the cow at freshening time.—Freshening time is a time when great care is necessary. It is usually the time when cows receive setbacks. If a cow does not do well during the freshening period, she is not likely to do well as a producer during the whole lactation period. The herdsman's skill and ability are usually tested to the maximum during this time, and it might be stated that it is usually at this stage that the inexperienced herdsmen make their failures.

The risks of the freshening period may be greatly reduced by attention, care, and good judgment on the part of the herdsman.

When possible, the cow should be put into a box stall previous to freshening, sufficiently early so that she may become accustomed to the new surroundings. It is not absolutely necessary that a cow have a box stall. A cow

may be heavily bedded and allowed to freshen in her regular stall in the barn, and the calf removed at once. This latter method is used almost entirely in Denmark. To remove the cow to a box stall is, however, strongly to be recommended. When the cow is ready to freshen, and especially at night, it is a good plan to put a halter on her and tie her to the manger in the box stall. If a cow is allowed to run loose, she may get the rear part of her body into such a position against the wall as seriously to interfere with the delivery of the calf. Besides, she may lie down in a part of the stall where it is impossible for the attendant to give her the necessary assistance. Most heifers need help.

As has been previously stated, the normal position of the calf is fore feet first and the nose resting between the knees and the forehead uppermost. The attendant should not be too hasty in assisting the cow. Most mature cows in good condition will freshen without any assistance. With heifers it is different. A rope tied around the fore legs of the calf will enable the attendant to assist. The attendant should not pull on the calf except when the cow assists by straining.

In case of abnormal position of the calf, the attendant should endeavor to get him into proper position to be born. If both legs are not out, the calf should be pushed back a trifle so that both feet will come first. This is especially true in case a calf is born backwards. At times calves cannot be delivered in this latter position. If this be the case, then the calf should be pushed back and turned around into the normal position.

In another connection the author has pointed out that it is usually best to leave the calf with its mother two or three days. It calms her and it is good for the calf. The cow should be milked in addition. Some prefer to take the calf away. They claim that a heifer will not long for her calf so much, and that she comes to her milk much quicker if the calf is not allowed to be with her. The method may be considered optional with the individual herdsman. The

author prefers to leave the calf with its mother two or three days. The mother's milk cannot be used anyhow for about this length of time, and it gives the calf a splendid start.

Under normal conditions, the cow should clean a few hours after freshening. If the afterbirth does not come within 24 hours, it should be removed. Any herdsman should be able to do this successfully. He should see that his nails are trimmed and hands cleaned very thoroughly and disinfected. The hand is gently inserted for the purpose of removing the afterbirth.

When the afterbirth has been removed, then irrigate the cow with a mild disinfectant. From one to two ounces of salt in one gallon of boiled water, cooled to 100 degrees F., makes a splendid douche for the vaginal tract.

CHAPTER XII

METHODS OF MILKING

The milking of cows may be done in two ways, by hand and by machine.

Hand Milking

Discussions in the previous chapter refer to hand milking. There is much difference in hand milkers. Some can milk rapidly without causing discomfort to the cow. Others, again, will cause discomfort to the cow no matter how slowly they milk. The hand milker must be able to understand the cow and to adjust himself to her.

The hands and fingers must be used in such a way as to imitate nature's way as closely as possible. The upper part of the hand or the thumb and forefinger should close around the teat. Then the other fingers should close gradually as the milk is pressed out. The milker should avoid pressing against the teat with the end of the fingers and the nails.



FIG. 79—Cows standing in the gutter with their hind feet are difficult to keep clean.

An average good hand milker will milk about eight cows per hour. A professional hand milker, or one who does nothing else, will easily milk 10 cows per hour. In large dairies, where such a man is employed, the milker usually has to milk 25 cows twice daily. Such a man is usually paid about \$40 a month, board and lodging. Counting board and lodging worth \$20 a month, this would mean a cost of 8 cents per cow for milking alone, or about the value of a quart of milk.

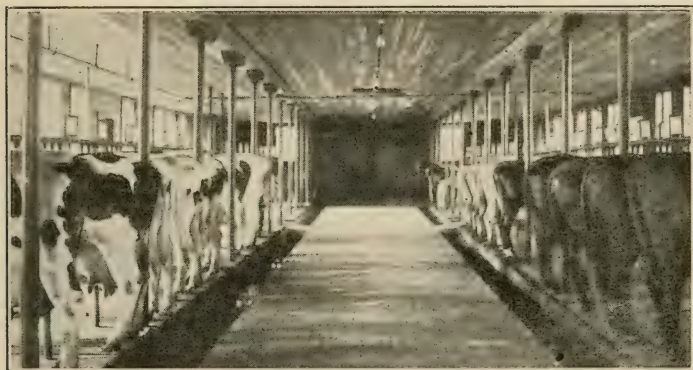


FIG. 80—A sanitary dairy barn, stalls of right length.

On dairy farms where special milkers are employed, the milking is usually begun at 12 o'clock midnight and 12 o'clock at noon, or soon thereafter, as it is necessary to get the milk to the consumers early in the morning and early in the evening. This insures fresh milk to the consumers at all times.

As soon as possible after the milk has been drawn, it is aerated, cooled, bottled, and delivered. In some instances the milk is also clarified and pasteurized. On the average dairy farm the milking should be done at seasonable hours of the day.

Machine Milking

On large dairy farms machine milking has become quite common. It is generally considered that when a person has 20 cows with good udders and teats, has a reasonably good barn, has the facilities for handling the milking machine, and a steady, interested, and intelligent operator, the milking machine can be economically operated.

Chief parts of the milking machine.—One of the chief parts of a milking machine is the pail and the pulsator. The pail is usually conical in shape, wide at the bottom and relatively narrow at the top. It is somewhat heavier in structure than the average tin pail. This is necessary to withstand the greater outside air pressure when the machine is in operation. The partial vacuum within the pail when the machine is in operation is about one-half an atmosphere, or nearly $7\frac{1}{2}$ pounds. This latter is equal to 15 inches on the gage which comes with the milking machine outfit. The pail capacity is also larger than that of the ordinary pail.

The cover fits on the top of the pail like a lid. A rubber ring acts as a cushion between the top of the pail and the under part of the cover. As soon as a vacuum is created in the pail, the cover is tightly drawn against the edge of the pail, making it air-tight. When the suction in the pail is relieved, the cover, with all of its attachments, can easily be removed.

Most of the milking machines have the pulsator attached directly to the top of the cover, thus making the cover an important part of the milking machine. The chief duty of the pulsator is to cause alternate suction and release. The first pulsators used on milking machines were put on the pipe line. This did not work very successfully. The later pulsators operate by vacuum and not by pressure.

Teat cups and rubber tubing constitute the real milking device. The teat cup is one of the important parts of the milking machine. The teat cups in the different machines

vary a great deal. Some of the machines have a straight, hard, conical-shaped cup. Others have a straight cup with a rubber sleeve extending through the cup and an air space cushion between this rubber sleeve and the outside of the cup. Others again have cups made entirely of rubber which collapses on one side. Other machines have cups made entirely of glass. Some have the universal teat cups, or just one size for all cows. Other machines have different cups for different sized teats.

Rubber tubing connects the cups with the inlet to the pail. There are thus two inlets through the cover of the double unit machines, or the machines that milk two cows into one pail. In addition, there is a heavy rubber tubing connecting the milking machine to the vacuum pipe running in front of the cow. This piece of rubber tubing, of necessity, must be stiffer and heavier than the other tubing, so as to prevent it from collapsing.

The vacuum iron pipes running in front of the cows are usually one-inch pipes, and are connected with the vacuum tank and pump in the power room. Some of the milking machines have no pipe line at all. A small pump, which supplies the right amount of vacuum and relief, is fastened and operated near the cow.

On the vacuum pipe in the barn there are a gage and a safety valve. The safety valve can be set to admit air into the system whenever a certain vacuum has been obtained. This obviates the danger of applying too much suction on the teat cups. Nearly all of the machines operate with from 15 to 17 inches of vacuum, or about one-half atmosphere.

The vacuum tank is placed between the vacuum pump and the vacuum pipes. This tank serves two chief purposes: to make suction more uniform and to act as a vacuum supply tank. If there was no larger supply of vacuum than just what was stored in the pipe line, then the vacuum would go down too low whenever the cups were taken off or put on, or in case one of the teat cups should happen to fall off.

The vacuum pump is one of the necessary parts of the

milking machine. The style of pump varies a great deal. Some use the rotary pump. Others use the pump having the up and down stroke. This pump is in operation all the time while the milking is being done.

It is necessary to have power of some kind. The amount of necessary power depends upon the number of units or milking machines in use. A two horse power engine is plenty large enough for two double units or for milking four cows at a time. Usually it is best to purchase a larger engine—one that may be used for grinding and other purposes as well. It is, however, not economical to run too large an engine for pulling so light a load.

In case electricity is available, a small motor is most desirable. This gives steady power.

The cost of a milking machine outfit varies. A double unit, or one pail with all of its attachments, costs about \$125. The piping and the pump cost in addition about \$75. A person should have at least two double units or three single units. Such an outfit costs, then, on the average a little more than \$300 without power. The price varies somewhat according to the kind of machine installed.

The cost of operation.—With such an outfit, one operator should be able to milk on the average about 20 cows per hour. If a man is employed to do nothing else but the milking, and if he milks the same length of time as is required by hand milking, as discussed in a previous paragraph, he should be able to milk about 50 cows in $2\frac{1}{2}$ hours. If the milker is paid the same as in the case of hand milking, about \$60 per month, the cost of milking for labor per cow per day would be 4 cents, which means that the cost of the labor has been cut in two. The interest on the investment and the repairs in case of machine milking also have to be considered. Counting the interest, repairs, depreciation, washing and disinfectant at \$150 a year, the added cost per cow per day would be about 1 cent, or a total of 5 cents per cow per day to get the milking done by machine,

while it costs about 8 cents per cow per day to get it done by hand.

Breaking cows to milking machine.—The author has experimented with eleven different types of milking machines and used them on Ayrshires, Guernseys, Jerseys, Holsteins, Shorthorns, and grades. In about seven years only one cow has been found which could not be broken to the milking machine. She was a grade Hereford. One milking machine expert stated that in all of his experience he has never seen a cow like her. It was not the action of the teat cups that excited her, but the clicking noise of the pulsator at her side. This annoyed her greatly. She has been in this herd continuously and she still objects just as seriously as ever to the use of the milking machine.

All of the other cows in the herd took readily to the milking machine. Heifers are even more easily broken to the milking machine than they are to hand milking.

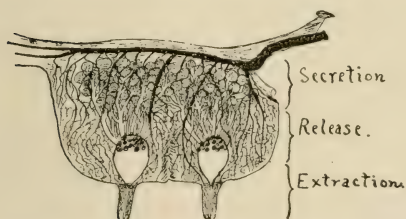


FIG. 81—Shows cross section of cow's udder and illustrates the three processes that must function together during milking.

The cows that give the most milk, that have square, symmetrical udders held close to the body, seem to be best adapted to the milking machine.

It is best not to attach the machine at once. Allow the cow to get used to the

clicking noise of the machine. When she gets used to this a little, then gently rub the cow's udder and get her to give down the milk. Then attach the machine. Do not leave the machine on the cow too long at first. It is better to leave a little more of the stripping to be done by hand than would regularly be the case.

Difference in cows for machine milking.—No two cows milk exactly the same. Even within one breed there is much difference in the manner in which the cows milk.

This difference has been noticed by all hand milkers. Each cow must, therefore, be handled and milked differently. If all of the cows were handled and milked alike by machines, mechanical milking could not be said to be a success, but by understanding individual cows and adjusting the milking machine in accordance with the characteristics of the cow, there will be very few cows that cannot be milked successfully with a milking machine. The difference in the suitability of cows to be milked mechanically was once brought to the mind of the author very forcibly. A certain person

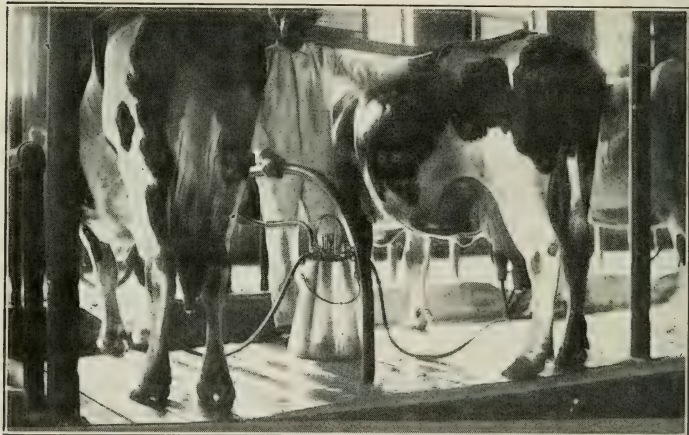


FIG. 82—These two large producing cows were milked with a mechanical milker during five consecutive lactation periods.

purchased a milking machine. It was operated only a short time when its use was discontinued. This same machine was then purchased second-hand by another man. He was very successful from the beginning, and continued to be successful. In fact, he was so successful with it that he later purchased an additional unit. Another dairy farmer, who owned a herd of pure-bred dairy cattle, also purchased a milking machine. The herdsman used it for a few months and then quit. This same machine was purchased by another dairy farmer, also owning a herd of pure-bred dairy

cattle, and he was successful with it. The difference must lie either in the cows or in the man who operates the machine.

There is much difference in the nervous temperament of cows. Some cows are quiet and appear never to be excited. They pay little attention to whether they are milked by hand or whether they are milked by machine. Other cows, again, are sensitive. This is true if milked by hand or by machine. A few cows in a herd may at first refuse to give down their milk completely. However, if the machine is operated by the regular attendant, and the cow is properly prepared, then the cows that will not milk well from the first are few in number. In fact, it may be said that they are limited to some few that give only a very small amount of milk and are very nervous.

Machine milking should not be forced too fast. Allow the cow a reasonable amount of time to get adjusted to the new method of milking. Immediately after freshening, or when cows are first taken from the calf, some cows give down their milk reluctantly. Excitement of any kind is likely to cause the cow to hold up the milk, whether milked by hand or by machine. Due consideration should be given cows in this condition. It is not advisable to start the milking machine too soon after freshening. At this time the milk from one or more of the quarters is likely to be abnormal.

Cows releasing milk slowly.—Some cows give down their milk very slowly. They may be grouped under three heads:

First, some cows do not readily give down their milk when milking begins; while others give down their milk as soon as the milker approaches them, or as soon as the milking machinery begins to operate. This rapidity of giving down the milk may, in some instances, be a habit of the cow. The writer, however, is led to believe that the manner of giving down the milk is natural and, therefore, is an inherited characteristic.

Second, some cows give down their milk very slowly, or little by little. Usually cows belonging to this class are not heavy milkers, and such cows do not milk well with milking machines. This slowness of releasing the milk may be due to two things. It may be due to simple inability to let down the milk readily. The milk ducts may not be sufficiently large to allow the milk to come down rapidly from the upper part of the udder. This is a natural characteristic and cannot be changed. Or it may be due to the cow's willfully holding up her milk and releasing it only at intervals or in jets.

Whether this slow release of milk is voluntary or involuntary, it seriously interferes with the operation of the milking machine.

Third, there are some cows that readily give down from one-half to three-fourths of the milk. The remainder is released very slowly and is often held up entirely by the cow when milked by machine. Such cows show a large percentage of milk in the form of strippings. If such cows are given time to release the milk fully before the machine is attached, and the work of the machine is not forced in the last stage of milking, this form of slow milking can be perceptibly helped.

Start machine in the early part of the lactation period.—

Some cows milk well by machine throughout the whole lactation period, while others respond quickly and readily to the milking machine only during the first part of the milking period and during the last part they are irregular. This is true when milked by hand and true when milked by machine. The hand milker, however, can adjust the milking to the cow. He knows exactly when the slowness of giving down the milk begins. The adjustment of the working of the milking machine to suit such a cow is not so easy.

Generally speaking, the latter part of the lactation period is not a good time in which to introduce the milking machine. Some of the cows are likely to hold up their milk

often enough and long enough to cause the cow to dry earlier than she otherwise should.

It is the different kinds of slow-milking milkers that are likely to cause most of the troubles encountered with milking machines. Those who have milked by hand know that about a pint of milk can be drawn from all cows. It is not necessary to wait for a cow to give down this milk. It is stored in the milk cistern in the lower parts of the cow's udder. A cow has no control over this. The obtaining of this milk is mechanical. It would be an easy matter to make a milking machine successful if all of the milk from a cow were drawn in a similar manner. It would simply be a matter of extraction of milk from the cow's udder. In this respect practically all of the milking machines, at least those in use in the experiments, have wonderful adaptability.

There are three processes involved during milking which must function harmoniously together: the secretion, the release, and the extraction.

When the first part of the milk has been drawn, the hand milker must wait until the cow releases or gives down her milk. Then the hand milker proceeds to milk two teats. In a short time there is no more milk. The hand milker then changes the operation to the other two tests. When there is no more milk in these, he returns to the first two, and so on until the cow is dry.

The milking machine is unable to do this changing from one-half to the other half of the udder, and to stop milking and wait for more milk. The milking operation is continuous. The machine is not conscious of the time when the milk supply runs low. Unless the milk has been released by the cow, it is not in the lower part of the udder to be drawn by the milking machine.

If no milk is released by the cow, the suction and pulsation of the machine are applied to the internal udder tissue of the cow instead of to the milk. When this happens there is much danger of the cow's willfully holding back, and she does not give down or release her milk normally.

The internal part of the cow's udder at this stage of milking is to some extent sensitive to this action of the milking machine. Some cows show signs of opposition and even discomfort by drawing up the stomach. When such a condition is reached, the milking machine and cow are working at cross purposes and not harmoniously. The cow holds up her milk and the machine continues to draw. This condition the operator should seek to avoid if he expects the milking machine to work successfully.

There is a difference between the action of the milking machine on cows that are holding up their milk, on cows that are entirely dry, and on cows that are partially milked.

Holding up of the milk and letting down only a small amount of it at a time interfere with the proper working of the milking machine. The applied vacuum from the machine is constant. As soon as the cow begins to release, the vacuum extends on up into the milk ducts and draws the milk quicker than it can be released. This the cow cannot stand, and when it occurs she immediately shuts off the milk supply to prevent the vacuum from going further into the milk ducts.

The cow that is entirely milked dry has closed all of the avenues leading to the mammary gland. These are closed continuously and there is no chance for the vacuum to act on any other parts of the udder than on the inside of the teat and milk cistern. With the amount of vacuum generally used (15 inches), few cows object to this.

At times one portion of a cow's udder is milked out quicker than the rest. It often happens that a cow has small front quarters. They contain less milk and are, therefore, milked out the quickest. This rapidity of milking the less capacious quarters of the udder is increased by the weight of the teat cups being largely on the quarter held up the highest. The cow may be giving down her milk rapidly and completely, and the milking machine doing good work until the front quarters are empty. When this happens, then the vacuum begins to extend up into the teats and

even into the gland proper. The cow objects to this. She immediately shuts off the passage ways. The cow cannot shut off one or two quarters and release the others. As a consequence a portion of the cow's udder is milked out entirely dry and the other portion is not. It is up to the operator to see that such cows are properly stripped out.

Symmetrical and well-shaped udders important.—The milking machines have a very wide range of adaptability for milking cows having unevenly shaped udders and teats of different sizes. However, if the udders of a few cows in the herd are abnormal, the required adjustments will probably be so numerous that machine milking will be more or less discouraging. Some herds contain cows whose hind udders hang low and the front udders high, or vice versa. The portion of the udder that hangs high carries the greatest part of the weight of the teat cups. As has been previously mentioned, weight applied to the teat cups causes the cow to milk out quicker. This means that one portion of the udder will milk out quicker than the other. At times such uneven milking may cause the teat cups to fall off. The skin of the empty part of the udder may fold. Air may be let in and in this way the cups may be released. It is evident that the length of the rubber tubes could be adjusted so that the weight on the four unevenly placed teats would be the same, but this would mean a change of tubes and cups every time such a cow is milked.

There are also cows having teats of uneven size and shape, and teats of poor quality for a milking machine. While it is true that there are very few cows having such abnormally shaped teats that the machine cannot milk them, with the aid of the right sort of an operator, it is also true that cows having well-shaped and medium-sized teats are easier to milk by machine and the teat cups are much easier to attach properly.

When teats are of proper size and shape, the milking machine gets a stronger and better hold, and there is less danger of having sore teats.

Occasionally the teats on machine-milked cows become hard, red, feverish, and a trifle swollen at the end. This soreness probably is due to a congestion of the blood caused by the steady suction. The soreness usually gradually disappears and will do so without necessitating the removal of the milking machine. It is possible that the quality of the teat may be a partial cause of this trouble. Some teats are soft and of very fine texture, while others are coarser in the make-up and are able to stand the constant wear of the milking machines.

In the average herd, there is only a small percentage of cows with such undesirable udders and teats. The prudent milking machine operator will cull such cows from the herd as soon as he can consistently do so. Such cows usually are not desirable to perpetuate in the herd anyhow.

From a commercial standpoint, the success of a milking machine is judged not so much by the large number of cows that milk well with it, as the small number of cows in the herd which cause the difficulties. If three or four cows in a certain herd appear to give a full flow of milk at one milking and a small flow at another, or if the teat cups fall off from one or more of the cows, or if one or more of the cows have caked udders, or if some of the teats are hard and sore at the end, or if the cows go dry three or four months previous to freshening, the milking machine is likely to be blamed.

Select and breed right cows.—If the milking machine is going to be a potent and stable factor in dairy farming in the future, dairy farmers must make an effort to select and breed cows that readily give down the milk, that have square, symmetrical udders held up close to the body, and that have teats of proper size and shape.

No heifers should be raised from cows that have undesirable udders.

The most important point in this connection is to use great care in selecting the herd bull. The wise dairyman will select a bull that comes from large producing ancestors, that

is pure of blood, and of good type. In addition, the female ancestors should have had well-shaped mammary organs and should have milked well. The male ancestors should be known to have daughters having milking characteristics that are suitable for mechanical milking. A tried sire, known to put good mammary organs on his daughters, is a good acquisition in a herd.

By thus applying care in this selection and breeding in the herd, in a short time none of the cows will be left that cause the chief difficulties in the successful operation of the milking machine.

Operator should understand principles and manner of milk elaboration.—The operator of a milking machine coordinates the machine and the cow. In order to do this, he should thoroughly understand the milking machine and each cow in the herd. Does she milk easily or with difficulty? Does she give her milk down only after an interval, or immediately after the milking machine is attached? Does she give down milk slowly, or quickly? Does she milk out well, or is there much stripping to be done? These are some of the things the operator must understand. He should have a complete conception of the manner in which the milk comes from each of the cows in the herd.

When a cow is being milked, three processes occur: The first is the secretion of the milk. This occurs within the mammary gland. It is in progress all the time. It is a natural function and an involuntary act. It cannot be controlled by the cow nor by the milking machine operator. This secretion of milk is closely connected with the nervous system of the cow. Through the nervous system, both the cow and the machine operator may affect, though not control, the secretion of milk. Probably an occasional or temporary excitement of the cow will not affect the milk secretion or work of the machine, but should this provocation continue, the production of the cow and the success of the milking machine would, without doubt, be hindered.

The second process is the release of the milk. This is a

very important part for the user of the milking machine to understand. The flow of the milk from the upper part of the udder to the lower part is controlled by the cow. The manufacture or secretion of the milk organs in the mammary gland occurs chiefly in the upper part of the cow's udder. The cistern or the milk reservoir is in the lower part of the cow's udder, or just above the teats. These extreme lower and upper parts of the cow's udder are connected by means of a complex system of tubes and vacuoles. These serve to conduct and store the milk within the cow's udder. These milk ducts branch and rebranch. The opening and closing of these tubes or ducts are controlled by most cows.

If the milking machine in any way produces discomfort to the cow, she is likely to hold up her milk. A cow having a very distended udder, or giving a large flow of milk, is not likely to do this, but if the discomfort of the machine is greater to the cow than the discomfort of retaining the milk, then the cow is likely to hold up her milk entirely or to give the milk little by little. This will either cause much stripping by hand, or if the stripping is not done, it will tend to dry up the cow early and may even cause diseased udders.

The third process is the extraction of the milk from the cow. Aside from the small amount of milk (about one pint) stored in the milk cistern, the machine cannot extract the remainder of the milk without the aid of the cow. Some have used the milking machine as though milking was only a question of extraction. If this were the only point to consider, the milking machine would be almost perfect. The use of milking machines has in a measure given the public the impression that extraction of the milk is all there is to a successful operation of a mechanical milker. The range of mechanical adaptability of the milking machines for extraction of milk from different cows is certainly great. Nevertheless, the cow is a living individual, and the milking machine cannot be attached and the milk drawn out as though she were some inanimate object.

In the beginning of the lactation period all cows are more nearly alike than at other times. The further the cows advance in the milking period, the greater the difficulties as to the manner of milking will be. It is especially with cows far advanced in the lactation period that the milking machine operator must learn to make the milking machine do good work throughout the year, and one year after the other.

Fit milking machine to cow.—The milking machine operator must not be in too big a hurry to attach the milking machine. Some cows give down the milk immediately, but others do not. Some cows will give down their milk as soon as the milking machinery begins to move. Others give down their milk as soon as the milk pail is at their side, and with still others the operator must coax by massaging and gently working with the udder.

The operator should slightly moisten the teats and bring them into normal condition. On cold, wet days, the teats

will be wrinkled and short. Before the cups are attached, the teats should be brought into normal shape. The operator should see that the teat cups get a proper grip on the teats.

Cows should be made to give down milk before machine is attached. — The operator can easily tell when a cow has given down the milk.

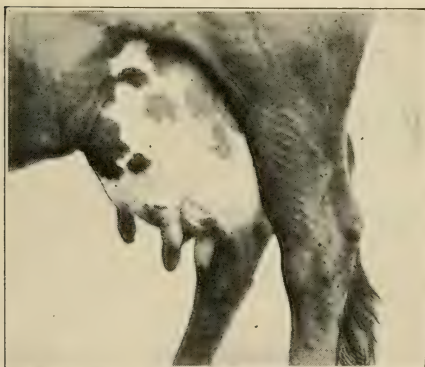


FIG. 83—Teat cups of milking machine should not be attached till teats have been brought into normal shape.

The teats and lower part of the udder will become warm and the teats fill full. Take time and prepare the cow properly before the machine is attached.

The operator should see that the teat cups properly fit the cow. Some of the machines have the universal teat cup. It has a wide range of adaptability. Other machines have different sized cups to fit cows having teats of different sizes. The milking machine operator should also understand how to regulate the pulsation to suit the individual cow. The rate of speed of the pulsator varies with the different machines. Even the length of the suction and the length of release in the pulsator varies. These the operator should understand how to adjust so as to make the machine do more efficient work without discomfort to the cow. A short, rapid pulsation is not suitable for a cow with long teats that is a hard milker. On the other hand, a long, slow pulsation is not conducive to rapid milking if the cow has short teats and is an easy milker. No rules can be laid down for this. The operator must use his own judgment.



FIG. 84—Showing condition of teats of the same cow, Fig. 83, when ready to have teat cups attached.

Milking machine surroundings should not be too cold. On farms where dairying is made a specialty, conditions are usually favorable for obtaining good results with the milking machine. The milking machine may be operated in any kind of a barn or shed, but in cold weather open and cold barns may cause so many little troubles that the person is likely to become discouraged with the work of the milking machine. Under such conditions, also, the cows sometimes shrink and are reluctant to let down their milk. The pulsator does not work well in frosty surroundings. The

moisture in the connectors and in the vacuum pipes freezes. The moist rubber tubes and teat cups may become icy when removed from the disinfectant solution and also after rinsing in water. The disinfectant solution is also likely to freeze. This latter, at least in part, may be prevented by adding salt to form a brine. A reasonably warm barn is one of the prerequisites for the most successful and agreeable use of the milking machine.

It is also a great advantage to have heating facilities for conveniently obtaining hot water for cleaning the parts of the milking machine, and even steam for sterilizing and cleaning the pails. A five horse power submerged flue upright boiler in the wash room near the milk room is a very handy and valuable adjunct to the dairy. If the machine and the different parts have to be taken to the house each time to be cleaned and sterilized, it makes considerable bother.

Keep milking machine sanitary.—The sanitary aspect cannot be neglected in any phase of the dairy business. Milk decomposes readily. Any portion not removed from the rubber tubes, cups, and other parts of the milking machine, and allowed to remain in them for any length of time, is sure to bring about insanitary conditions.

The milking machine is very efficient in excluding all kinds of visible dirt. The sediment from the udder, sides of the cow, and barn surroundings, at times seen in hand-drawn milk, has no chance to gain access to milk drawn by the milking machine. However, special care needs to be used in order to keep strictly sanitary the teat cups, tubing, and pails. If this is not done, the bacterial content of the milk will run very high.

That these different parts of the milking machine are a constant source of germs is clearly seen from the following figures: The average number of germs per cubic centimeter in the milk drawn from the first cow milked with the machine, although kept sanitary, was 5325. The average number of germs in a cubic centimeter of milk from the

second cow, drawn by the same machine, was 3017, and from the third cow, milked by the same machine, the number per cubic centimeter was 3012.

The different parts of the machine were kept in a sanitary condition; otherwise the germ content would have run extremely high with the first cow. The pail, rubber tubes, and all cups were thoroughly cleaned and scalded. The tubing and cups were kept in a disinfectant solution between milkings. The milk pail, after being cleaned, rinsed, and steamed, was kept in the milk room in an inverted position on a shelf between milkings.

The above data shows that even though great care is taken, the tubing and pails are a source of germs in the milk. Where certified milk is desired, the pail should be thoroughly steamed just previous to milking.

A practical way of keeping a milking machine sanitary is to rinse it thoroughly after milking is completed, before the milk dries on to the different parts. This is accomplished by having a vacuum connection in the wash room, and then attaching the machine to the vacuum pipe. Then insert the teat cups in the rinse water and slowly raise them up and down. This causes the rinse water to gush back and forth and wash off the remainder of the milk. Then take the machine apart, and with special brushes these parts are cleaned in lukewarm water containing some washing powder. Then rinse these different parts in clean water and transfer them into the disinfectant solution.

There are several disinfectants from which such a solution may be made up. The author has experimented with a large number of them and has come to the conclusion that for cheapness, simplicity, and effectiveness, all considered, there is nothing better than ordinary lime. It excels as a deodorizer. It freshens and sweetens the different parts of the milking machine. The ordinary limete purchased in paper sacks has proven handy and efficient. With this it is easy to make up a uniform and fresh solution. A new solution should be made up not less than

once each week. In the summer time it should be made up twice each week. A two percent solution by weight is suitable. A solution stronger than this does no harm. Do not put any of the milking machine parts into this disinfectant until they have been thoroughly freed from all milk particles and other organic matter.

The pail and other parts of the milking machine should be washed and steamed out, and kept as is recommended for other forms of milking utensils.

The vacuum pipes should also be carefully looked after. These should be washed out as often as is necessary; usually once a month is sufficient. If the milker allows the pail to get too full of milk, some of the milk and foam will be drawn into the pipes. Then the cleaning should be done frequently. Considerable moisture, however, evaporates from the milk and condenses in the vacuum pipes. In addition, dust and foreign substances will accumulate. This will cause foulness in the vacuum pipes, even though no milk gained access to them. Wash out the vacuum pipes at least once a month. Where no vacuum pipes are employed, the pump should be kept strictly sanitary.

Watch closely for abnormal milk.—In connection with obtaining sanitary milk from a mechanical milker, the operator should carefully watch that none of the cows produce abnormal milk. There are times when a cow's udder will give milk that is not normal and sanitary. If care is not exercised, such milk will gain entrance to the pail. If a cow's udder is gargety and swollen, take no chances; milk the cow by hand. The appearance of stringy, lumpy, colored, abnormal milk cannot be blamed to the milking machine. Such abnormalities are likely to occur with the individual cows, whether milked by hand or machine. It is the duty of the operator to be on the watch for difficulties of this kind.

Kinds of Milking Machines

There are now many different types of milking machines manufactured, and on the market. Only the chief ones, the

ones with which the author has had considerable experience, and the ones manufactured and sold in the United States, will be considered in this connection.

Burrell-Lawrence-Kennedy milker (B. L. K.).—The B. L. K. milker operates from a vacuum pipe line—usually installed on the stanchion frame. The vacuum is supplied by a two-cylinder vertical pump driven from a counter shaft. Two gages are used to indicate the amount of suction. These are located at convenient places for reading and at some distance apart on the vacuum pipe line. One gage is of the mercury column type. The other one is a dial indicator. A vacuum of about 15 inches is used. The uniformity of the vacuum is regulated by a weighted valve. This valve can be set so that the vacuum does not go above the regulated amount. Connection cocks to the pipe line are fastened between each pair of cows. The pipe line is installed so that it has a drop of 50 inches in 50 linear feet. A drain cock is put in on the lowest point to allow drainage of moisture collecting in the pipes.

The milker proper consists of a 28-quart pail of non-corrosive material. The pail has a partition in the center so that the milk from the two cows milked into the same pail may be kept separate. The pail cover contains the pulsating device and trap valve. The vacuum is transmitted from the stanchion cock through a $\frac{1}{2}$ -inch heavy rubber tube to the trap valve. This latter prevents any substance from the pipe line entering the pail. The pulsating device controls the action of the suction upon the cow's udder. It is so ar-

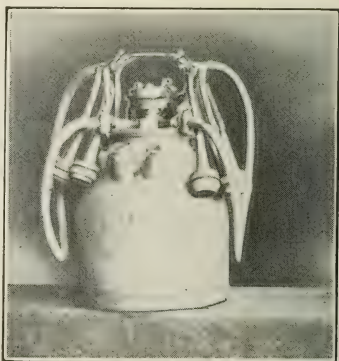


FIG. 85 — Burrell-Lawrence-Kennedy milking machine.

ranged that the suction is applied intermittently. The speed of pulsation is controlled by a thumb screw, which governs the amount of vacuum entering the pulsating mechanism. The speed of this pulsator that is most efficient for milking the average cow is about sixty times per minute. The moving parts are enclosed in a metal dome and are thus protected from accidental injury. A single rubber tube, with a cluster of four teat cups at one end, leads from the pail to the cow.

The teat cups are of the single compartment metal type, with a rubber disc mouthpiece, which serves to hold the cup in place and forms a close, yet not a binding connection with the teat. Several sizes of teat cups are furnished with the machine to fit different cows.

The air that enters the milk tube to relieve the suction is filtered through absorbent cotton.

The Calfway milker.—This machine operates with vacuum in a manner similar to the machines described above. A rotary pump is used instead of the vertical pump. This machine is operated with about 17 inches of vacuum.

The vacuum pipe is also supplied with a safety valve and a vacuum dial indicator.

The pulsator is located on the top of the pail cover. The average speed of the pulsator for this machine is about 65 pulsations per minute. This can be regulated to suit the cow. The teat cup is made of rubber. The outer wall of the teat cup is rigid on one side and flexible on the

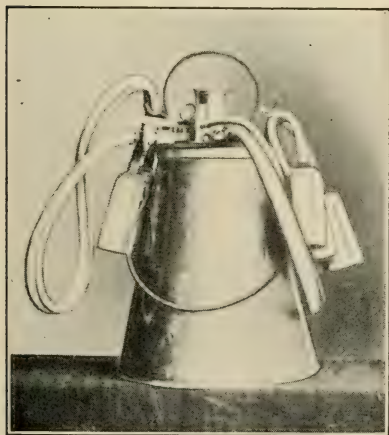


FIG. 86—The Calfway milking machine.

opposite. The inner wall, or sleeve, is a continuation of the outer. It is made of thinner material and is flexible throughout. The inner part of the teat cup, or sleeve, is open at the lower end to admit the passage of the milk. When suction is applied to the cups, the flexible side of the outer wall bends in and exerts a slight squeeze on the side of the teat. This is known as the collapsible teat cup. Several sizes of teat cups are manufactured to fit different cows. This machine is not now placed on the market.

The Empire milking machine.—This milking machine operates from a vacuum pipe line in a manner similar to the two machines described above. The pipe line is supplied with a safety valve and a dial vacuum indicator. This machine is operated with about 15 inches of vacuum. Two cows are milked into one machine at one time.

The Empire mechanical milker has the Universal teat cup—one size cup for all cows. This teat cup has two walls. The outer wall is made of rigid metal. The inner wall is made of thin, flexible rubber. The space between the two walls is air-tight, and is connected to the pulsator by a separate tube. When the cup is placed on the teat and the suction turned on, the rubber sleeve, or inner wall, collapses. This practically shuts off the suction on the side of the teat. By the mechanical action of the pulsator the suction is released

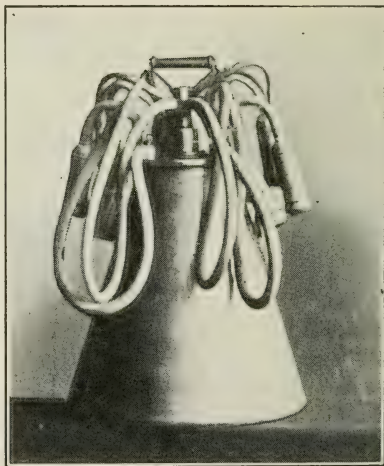


FIG. 87—The Empire milking machine.

on the teat and applied to the space between the walls. The shifting of the vacuum in this manner continues, due to the

action of the pulsator. About 50 pulsations per minute is the most efficient speed. This varies some, according to the ease with which the cow milks.

The Perfection milker.—Vacuum is supplied to this machine in a similar manner as described above. About 15 inches of vacuum is applied. This machine milks two cows into one machine at a time.

This machine uses the Universal teat cup, or the same size cup for all cows. The teat cups are of the double wall

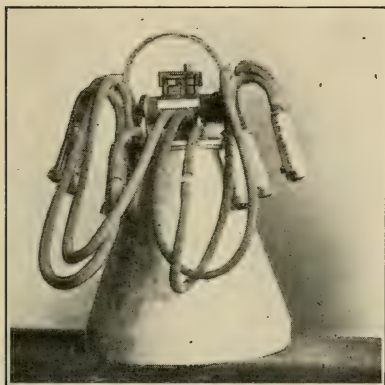


FIG. 8.—The Perfection milking machine.

type. The inner wall is made of thin rubber, and the outer wall is made of metal. The space between these two walls is air-tight, except the tube inlets. Two rubber tubes lead from the vacuum pipe to the milker. One conveys the suction to the teat and returns the milk to the pail. The other conveys the suction to the space between the outer and inner walls of the teat cup. When suction is applied to the teat, or center of the cup, the inner wall, or rubber, inflates inwardly. When the suction is applied to the space between the walls, the rubber inflates in the opposite direction and releases the teat. This alternate action is controlled by the pulsator. The force of the suction and the length of the squeeze stroke may be regulated independently by a set of needle valves; that is, there is a dual control—one of the suction and one of the release.

The Sharples milker.—This mechanical milker employs a double system of pipes. A vacuum pipe carries a similar amount of vacuum as described with the above machines,

15 inches, and also an air pressure pipe. The amount of air carried in the pressure pipe is seven pounds.

The pulsator is located on the pipe line. It is a horizontal tilting cylinder. It is detachable and independent of any of the other parts of the milking machine. This pulsator also has a dual control. The length of the release and suction is not necessarily the same. Fifty-five pulsations per minute is the most satisfactory speed with the average cow. With a cow that milks easily, the suction and release should be of equal duration. With a hard milker, the force of the suction should be applied longer than the time of release. The Sharples has the Universal teat cup. It is

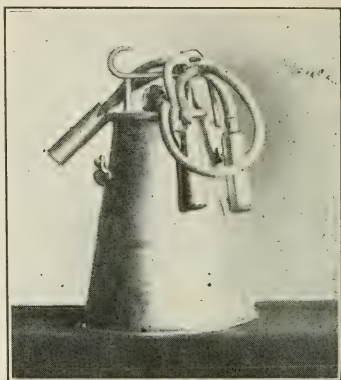


FIG. 89—The Sharples milking machine.

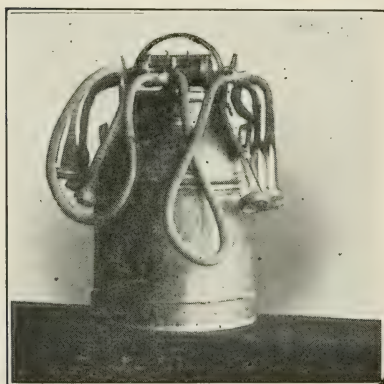


FIG. 90—The Waterloo Boy milking machine.

of similar structure as are the other Universal cups. The inner wall consists of rubber and the outer is made of metal. This machine is of the single unit type; that is, only one cow is milked into one pail at a time.

The Waterloo Boy milker.—Only one pipe line is used with this machine. About 15 inches of vacuum is carried. The suction is

applied directly to the teat in regular intermittent strokes—similar to the Empire and B. L. K. The speed of pulsation is about 55 strokes per minute and may be regulated by a thumb screw. There is no dual control of the pulsator. The suction and release are of equal duration.

The teat cups are of the single compartment type, fitted with a rubber disc mouthpiece for retaining the cups in place. Various sizes of cups are used. Cups made of glass are manufactured for this machine.

The Hinman milker.—This machine operates with direct intermittent suction. The suction is obtained directly from a small independent pump near the cows. There is no vacuum pipe line in connection with this machine. Each machine in operation is independent of every other machine.

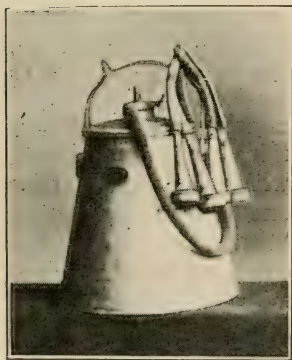


FIG. 91—The Hinman milking machine.

The small pumps are so made that 15 inches of vacuum are applied to the teat at every stroke. By opening the pit cocks in the pump, this vacuum may be lowered to about 12 inches. The speed of pulsation is determined for all machines by the speed of the driving shaft. This speed is constant and is from 45 to 50 strokes per minute. When the suction is lowered by the back stroke of the pump, the weight of the milk opens the gravity valve and allows the milk to drop into the

pail. The valve chamber is situated in the pail cover. There is no vacuum in the pail. On this account, and on account of only one cow being milked into one machine, the pails are much lighter.

The teat cups are of the single compartment, cone-shaped type, with a retaining rubber disc mouthpiece. Various sized cups are manufactured to fit teats of different cows.

The Disbrow milker.—This machine works without a vacuum pipe line—similar to the Hinman. Practically the only difference is that this machine milks only two teats at a time. It has a double acting pump. The milk is first drawn from two quarters of the cow and then from the other two quarters, and continues to alternate in this manner till the cow is milked.

The Mehring milker.—This particular machine is operated by foot power. It is intended for use in small herds only. The pumping device and

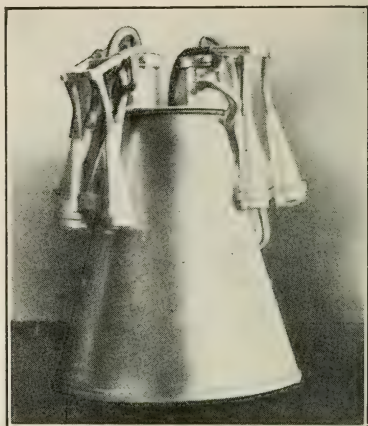


FIG. 92—The Disbrow milking machine.

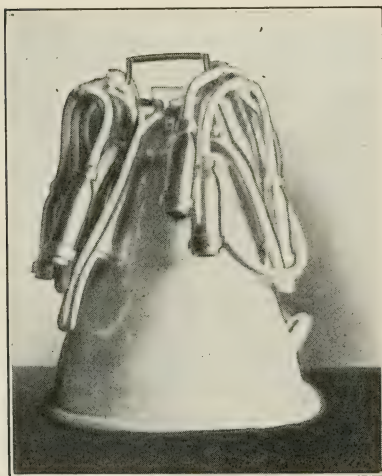


FIG. 93—The Universal milking machine.

attachments are all contained within one unit, which is carried from one pair of cows to the other. It milks two cows at a time, and milks directly into a pail hung on the pump. The amount of vacuum may be varied according to the rapidity with which the operator works it.

The Universal milk-er.—This is one of the latest milking machines. It is operated by vacuum similarly as the other pipe line machines, and

about the same amount of vacuum is used, viz., 15 inches. This machine alternates the suction from two quarters to the other two. The milk is drawn from two teats at a time. The attachment of the cups determines which two teats are milked together at a time. The release is similarly alternated.

CHAPTER XIII

HANDLING AND MARKETING MILK FOR DIRECT HUMAN FOOD

Composition of normal milk.—The average composition of cows' milk is as follows:

Water -----	87.2	percent
Fat -----	3.8	"
Proteids: 3.5 percent		
Casein -----	3.0	"
Albumen -----	0.5	"
Milk-sugar -----	4.8	"
Ash -----	0.7	"
Total -----	100	"

The composition of cows' milk varies. Two factors that cause variation are the breed of the cow and the individuality of the cow. These have been discussed in chapters III and IV.

A third factor is the length of time between milkings. The more nearly the time is equalized, the more uniform will be the quality of the milk. Intervals between milkings are not always of the same length. After the long intervals the cows give milk containing a smaller percentage of fat than after short intervals. The distention of the cow's udder, due to the large amount of milk, has a retarding influence on the activity of the fat-secreting cells. It is also possible that when this distention reaches a certain point there is a reabsorption of the milk by the blood. Even if the intervals between milkings were exactly the same, the milk from the morning milking will usually contain a slightly smaller percentage of fat than that from the evening milking. It appears that the greater activity in the

fresh air and sunshine of the cow during the day has some influence on making the milk a trifle richer.

Fourth, the manner of milking affects the richness. It is a well-known fact that the milk drawn at the different milking stages does not have the same composition. The very first milk contains less than one percent of butter fat. The very last milk may contain 10 and even 12 percent of butter fat. The milk ranges between these two extremes in composition. It can, therefore, readily be seen that the milker who can milk so as to obtain all of the strippings will get richer milk from the same cow than will one who either neglects to milk the cow properly or who causes such discomfort to the cow that she does not give down the milk completely.

The Hegelund method of milking consists of gently lifting and massaging each quarter of the cow's udder in the latter stage of the milking process. The University of Wisconsin conducted some experiments and found that the quantity of fat was increased by 9.2 percent, and the amount of milk was increased by 4.5 percent.

With the average cow, the author does not believe it will pay to strip the cow too long, nor will it pay with average cows and under average conditions to manipulate the cow's udder according to the Hegelund method, in order to obtain this rather small increment in milk and butter fat. An experienced milker is able to get all of the milk by the ordinary process of milking. Some cows, however, require that the udder be manipulated in the latter stage of milking in order to obtain all of the milk.

Fifth, the environment may affect the richness of the milk. Generally speaking, any unfavorable environment which will cause the cow to give a smaller flow of milk will usually cause the milk to be a trifle richer than usual. If these unfavorable conditions continue for any length of time, then the percentage of fat will go down to normal. It should be stated, however, that such occasional unfavorable surroundings do not cause the richness of the milk to in-

crease to such a proportion as to make up for the decrease in the milk flow. Cows exposed to a cold day, for instance, will lessen the flow of milk considerably, but the percentage of fat is usually increased a trifle. If the unfavorable environment continues, then the percent of fat will soon become normal.

Sixth, the condition of the cow is another factor that affects the richness of milk. A cow freshening in a fat condition nearly always gives richer milk shortly after freshening than the same cow would if she was in poor condition or lacking in body flesh. When the surplus body fat has been milked off, the milk becomes normal in richness.

So far as known now, no kind of normal food will cause the milk to increase in richness, if the cow has once reached the normal and natural condition. This is contrary to the general belief. Many practical farmers hold the idea that if a cow is well fed she will give richer milk than if she is poorly fed. A cow well fed will give a greater amount of butter fat than will one that is poorly fed. One must be careful to distinguish between percent of fat and amount of fat. A cow well fed will give a larger flow of milk of normal richness and therefore a larger amount of fat.

Seventh, the stage of the lactation period affects the richness of the milk. When a cow has given milk about two months, her milk is normal in respect to richness. If properly and normally fed, she will give a uniform flow for another two or three months. If she is then in calf, the flow of milk will gradually decrease until her resting period. This latter begins about six weeks before freshening. With this gradual decrease in the amount of milk there is a small and gradual increase in the percentage of butter fat in the milk. A cow giving milk testing normally $3\frac{1}{2}$ percent butter fat will produce milk that tests four percent butter fat and even a little more towards the latter part of her milking period.

Bacteria in milk.—No matter how much care is exercised in the production of the milk, some germs will gain

access to it. The fore milk, or the first milk drawn, contains some bacteria while it is still in the cow's udder. They enter through the opening of the teat. These bacteria find ideal conditions for multiplying. The temperature is suitable, there is plenty of feed and plenty of moisture. When certified milk is produced, this fore milk is drawn into a separate container and is not mixed with the remainder of the milk. By this method the bacterial count of the milk is materially reduced. Certified milk must not contain over 10,000 bacteria per cubic centimeter.

The remainder of the milk from a healthy cow's udder contains practically no germs. This milk, however, cannot be exposed to the air and handled in utensils under practical conditions without a large number of germs getting into it.

It may be said that if these germs are of the harmless kind their presence in the milk makes very little difference, since germs are present everywhere anyhow and we consume them by the thousands in practically all other foods. From the standpoint of affecting a grown person's health, the presence of non-pathogenic germs in the milk is not of great importance.

The presence of bacteria in the milk will, however, at the proper temperature cause the characteristics of the milk to be changed. At temperatures between 60 and 90 degrees bacteria multiply very rapidly in milk. They feed upon the sugar of milk and change it into lactic acid chiefly. This causes the milk to sour and coagulate. Some species of bacteria feed upon the protein of the milk and produce undesirable taints and gases. Other species attack the butter fat and produce rancidity. These things the different species of bacteria accomplish in milk if they have both time and suitable temperature.

Such fermentation in milk may be checked, first, by excluding as many bacteria as possible from entering the milk by strictly sanitary methods; secondly, by heating the milk to a temperature of 140 to 185 degrees; and thirdly, by cooling milk below 50 degrees. Cooling the milk does not

kill bacteria. It merely renders them inactive. The method of handling the milk after it has been drawn will depend on how it is to be marketed. In the eastern part of the United States, and near the large cities, the milk produced is generally sold to serve as a direct food for people. In the central West and Northwest the milk produced is chiefly used for the manufacture of butter, cheese, condensed milk and powdered milk. The by-products are fed chiefly to calves and pigs.

The following outline illustrates the various common uses to which whole milk is put.

I. Handling and marketing milk for direct human food.

1. Wholesale in bulk.
2. Delivered and retailed direct to consumer.
3. Used in home.

II. Making butter on the farm.

1. Skimming cream of medium thickness.
2. Keeping separator in good condition.
3. Churning fresh cream.
4. Washing the butter.
5. Salting the butter.
6. Working the butter.
7. Packing and marketing butter.
8. Difficult churning.

III. Selling the cream to be made into butter in the factory.

1. Local creamery.
2. Cream buying station.
3. Direct shipping to central plant.

IV. Making cheese on the farm.

1. Coagulating with rennet.
2. Cutting the curd.
3. Heating the curd.
4. Preparing cheese for press.
5. Pressing the cheese.
6. Curing cheese.

V. Manner of disposal affects income.

Direct Consumption

Cooling and aerating the milk.—No matter for what purpose the milk is produced, it should be clean and whole-

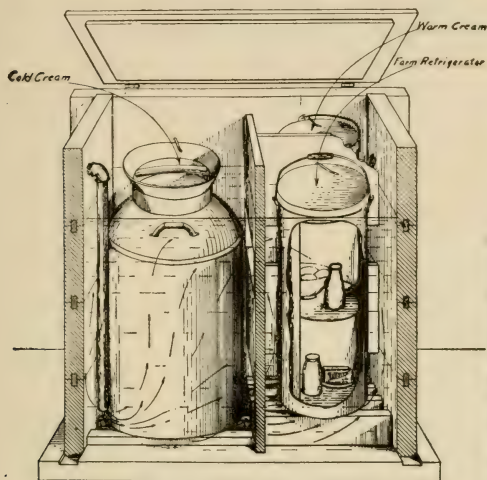


FIG. 94—Official square cooling tank.
(Neb. Sta. circular No. 3.)

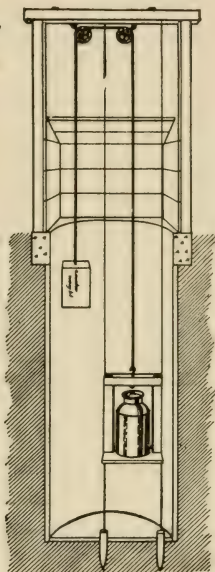


FIG. 95—An elevator
and cooling well.
(J. H. Frandsen, Neb.
Exp. Sta.)

some in every respect. When the milk is for direct use, whether for the home, or for the retailer, or for the customers direct, the milk should be cooled and aerated at once after it has been milked.

The sooner it is cooled after milking, the better, and the lower the temperature to which it is cooled without freezing, the better. The animal heat should not be permitted to remain in the milk any length of time. A piece of meat which has been covered and has not had the animal heat taken out shortly after the butchering will have an objectionable flavor. A can of milk covered and left warm will have a smothered flavor, to which most milk consumers object.

It is important that the milk should be cooled to below 50 degrees. On the average dairy farm, water alone will not

cool milk lower than to about this temperature. When ice or mechanical refrigeration is obtainable, the milk should

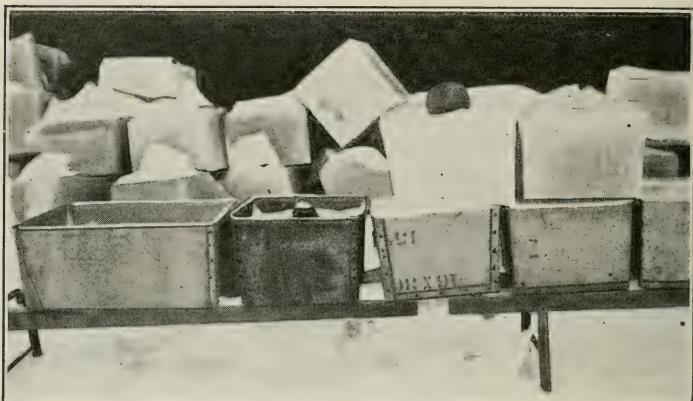


FIG. 96—The manufacture of sanitary ice in cans. This method is useful on'y in a cold winter climate. (So. Dak. Sta.)

be cooled to 40 degrees. When the milk is to be sold for direct use, it should be cooled by running over a cooler and aerator. Special cooling apparatuses are now on the market.

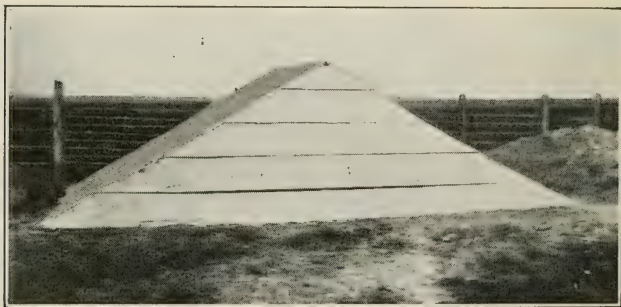


FIG. 97—A covered ice pit. It is an inexpensive way of keeping ice on the farm.

The ice-cold water or brine circulates on the inside of the cooler and the milk flows over the cold surface of the cooler in a thin sheet. The cooling and aerating should be done in

a pure and well-ventilated atmosphere. If these processes are properly done, many of the taints, if any are in the

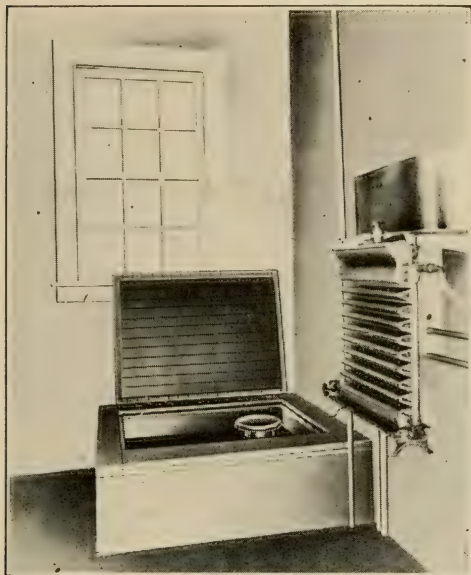


FIG. 98—A method of cooling and aerating milk.
(U. S. Dairy Division.)

milk, will be eliminated and the temperature lowered to such an extent as to check the growth of the bacteria; and if the milk is cooled to a temperature as low as 40 degrees the growth of all germs is practically stopped.

If the amount of milk produced is small, and the farmer does not have facilities for such a method of cooling, the cans

of milk may be placed in cold water as soon as possible after milking. A stream of cold water should be pumped through the tank and the milk cooled thoroughly. The milk should be kept at this low temperature until it reaches its destination.

This keeping of milk in cold water should be practiced in winter as well as in the summer. During the winter, the cans of milk should be submerged in the water to such an extent that the level of the water in the cooling tank is above the level of the milk inside of the can. This will prevent the milk from freezing.

When the dairyman is ready to deliver the milk in the summer he should cover the outside of the can with a wet

blanket and leave it in that condition while en route. If the cans of milk are to be shipped by train, special can covers are now obtainable which tend to keep the milk from being warmed too rapidly. In the winter time a dry blanket should be put around the can while en route to prevent the milk from freezing.



FIG. 99—After returning from the milk route on a cold morning.

Milk produced, handled, and kept in this manner will be in good condition for home use, for delivering to the retailer, and for being bottled and delivered directly to the consumer.

If the milk is to be manufactured into factory cheese, into condensed milk, or into powdered milk, without being skimmed or modified in any way, then the above discussion of handling milk also applies.

CHAPTER XIV

HANDLING MILK TO BE MANUFACTURED INTO DAIRY PRODUCTS ON THE FARM

Making Butter on the Farm

Skim cream of medium richness.—If the milk is to be manufactured into butter, the milk cannot be handled in the same manner as where it is intended for direct use. There is a tendency at the present time to not manufacture the milk into any dairy products on the farm, and an increased tendency towards selling the milk or the cream in the unchanged form.

However, there is still much farm butter manufactured, and it is highly important that this butter should be of the very best quality.

When the milk is to be made into butter, it should be skimmed at once after milking, while the milk is still warm. From the standpoint of the flavor of butter, richness of cream is not an important factor. From the standpoint of workmanship of butter, it is of considerable importance. Cream may be so rich and so thick and viscous that it will not agitate in the churn without warming to such a temperature that the churned butter will be too soft, and thus contain too much of the buttermilk constituents. Too thin cream should also be discouraged. When very thin, the butter will not gather on churning. If it does not gather, there is likely to be a big loss of butter fat in the butter. The butter granules will "break" in small shot-like forms.

During the summer, cream should contain from 35 to 40 percent of butter fat. During the winter, the proper richness is between 30 and 35 percent of butter fat.

Practically every cream separator has a device on the

bowl which serves as a regulator of the richness and which influences the relative amount of cream and skim milk discharged from the separator. In most cases this device takes the form of a cream screw. Turning it towards the center of the separator bowl will make the cream richer. Turning it away from the center will make the cream less



FIG. 100—Shows butter lost in skim milk from one cow by different methods of skimming. (Purdue Exp. Sta.)

rich. In a few machines this device takes the form of a skim milk screw. The method of regulating the richness of cream then works just in the opposite direction. When richer cream is desired, then the milk screw is turned so as to bring the skim milk outlet nearer to the surface of the bowl. If thinner and therefore relatively more cream is wanted, then the screw is turned in, or nearer the center of the bowl.

The amount of whole milk which runs through the separator affects the richness and relative amount of cream and skim milk. The greater the inflow of whole milk to the separator the thinner cream will be obtained. If the flow is diminished, then richer cream and relatively less of it is obtained. This is due principally to the fact that the skim milk outlet has a limited capacity. If the inlet is increased, it can readily be seen that the increased discharge must take place through the cream outlet.

The speed of the separator is an additional factor which

influences the richness of the cream and, therefore, also the relative amount of cream and skim milk. The slower the bowl revolves, the smaller the proportionate amount of skim milk discharged, and consequently if the inlet is constant, more and thinner cream will be the result. In this



FIG. 101—An inexpensive method of cooling and aerating milk. (U. S. Dairy Division.)

connection it should be stated that the efficiency of skimming depends to a large extent upon the speed, and if attempts are made to decrease the percentage of fat and increase the amount of cream by lowering the speed, too much fat will be left in

the skim milk. The thoroughness of skimming depends very much on the speed. Every separator has a speed at which it works best. This speed varies with different separators. It is important that the speed of the cream separator be uniform both from the standpoint of getting thorough skimming and also from the standpoint of getting a uniform richness of cream.

Electric or gasoline power is more conducive to uniform speed of the separator than is hand power. There is an increasing tendency to use gasoline and electric power for running the separator.

The temperature of milk slightly affects the richness of cream. When milk is first drawn, the temperature is about

100 degrees Fahrenheit. At this temperature it is more fluid and a trifle more of it will run through the separator in a given time than when it becomes colder. This slightly lowers the percent of fat in the cream. The cream outlet of some separators will clog when the temperature reaches about 50 degrees. When this point is reached, then the percent of fat in the cream is slightly increased. It is important that the milk be skimmed at once after milking, while the milk is warm, or that it be warmed to about 100 degrees before it is skimmed.

The percent of fat in the milk affects the richness of the cream skimmed. On the average farm, this one factor is not likely to vary much from day to day if the cream is always from the same herd and skimmed in the same separator. Milk from the same herd will be almost of uniform richness from day to day. There will, however, be some difference in the richness of the milk from one season to another, even though the milk comes from the same herd. The percent of fat in the cream is in direct proportion to the fat in the milk separated.* For instance, the milk may test four percent of fat and the resulting cream contain 30 percent of fat; but if the percent of fat in the milk was increased to five percent, then the percent of fat in the cream from the same separator would be increased to 37 percent ($4:5 :: 30:x = 37 + \text{percent}$).

The richness of the cream from a farm separator also depends on the amount of flush water used. The last act in skimming is usually to flush the bowl with a dipperful of clean water. The chances are that this amount of flush water is uniform, whether 100 pounds of milk are skimmed or whether 200 pounds of milk are skimmed. The effect of this flush water on the richness of the cream will be more marked from one season to the other than it will from day to day. The amount of cream skimmed is fairly uniform from day to day, but it usually varies more from one season to the other.

* Bulletin No. 94, Missouri station.

There is much discussion over the test of the cream. It is important that all producers understand that cream varies from day to day, due to the above-mentioned factors.

Keep separator in good condition.—Generally speaking, too little importance is attached to the efficiency of the farm separator. At times cream separators are not put on a level and solid foundation. This is very important.

Secondly, cream separators are not always kept clean and well oiled. The bowl bearings in time will become gummed

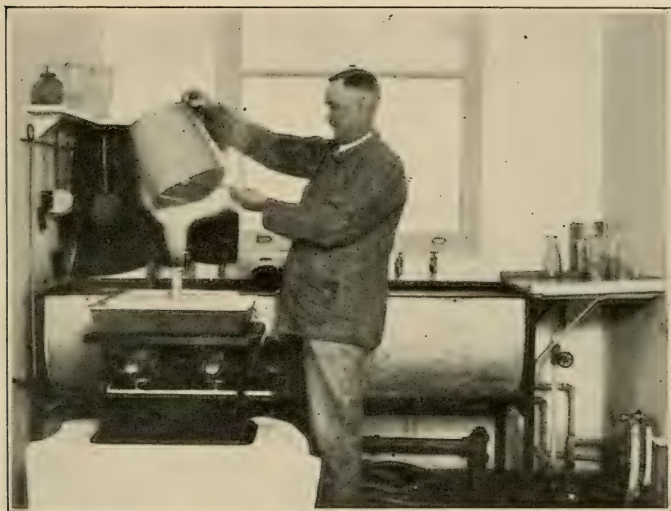


FIG. 102—A home sterilizer. (U. S. Dairy Division.)

up. This will cause the cream separator to run heavily and make the bowl wobble. By flushing the bearings at least once a week with kerosene, this gum will be removed. The separator should be well oiled daily, both previous to and during the separation. Do not use too heavy lubricating oil.

The separator must be kept scrupulously clean. It is a well-known fact that at the close of the skimming process there is always a thick, heavy substance adhering to the bowl wall. In addition there will be some slush left in the

bowl. If this is not removed, it may become unevenly distributed in the bowl, and therefore cause the bowl to run unevenly when it gets up to speed. A very small unbalancing of the bowl when standing still will greatly unbalance the bowl when full speed is reached. The smooth running of a cream separator is one of the first essentials. If a machine runs roughly, there will not be good separation, and it is more or less dangerous to run it. The bowl itself is likely to jump out or burst. The causes for unsteadiness in running are many. Usually it is due to the machine not standing level, to dents on any parts of the bowl, to using dirty and worn out bearings, and to improper balancing of the internal contrivances of the bowl, to lack of cleanliness of the bowl, or to a bent or sprung spindle.

Churn fresh cream.—

As soon as the cream has been separated, cool to as low a temperature as is possible without freezing. The cooling of cream is done in much the same way as is the cooling of milk already described.

Never mix warm and cold cream. Before the fresh, warm cream is mixed with the cool cream it should be thoroughly cooled. Old cream is sure to have an old, stale flavor. In spite of the cleanliness with which it has been produced, and the coldness in which it has been kept, some germs will develop in the cream and cause abnormal flavors.



FIG. 103—A sanitary hand churn made from glazed earthenware.

The fresher the cream is, the better the chances for a good-flavored cream from which to churn butter. The dairy farm that has the largest number of cows or the greatest amount of cream usually has the best cream and makes the best butter. This is due chiefly to the fact that the churning is done oftener. Cream should be churned at least twice a week to make the best butter.

There are some who believe that cream must be sour before it will churn. Sour cream is not necessary. This

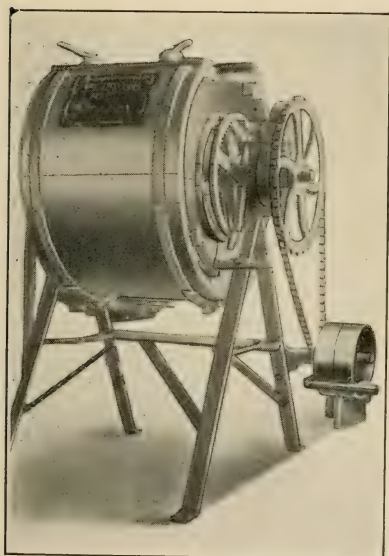


FIG. 104—A small combined farm churn.

idea of sour cream has probably come from creameries. In butter factories, the cream is usually pasteurized and ripened with a good starter before it is churned. This is done with a view to controlling the kind of fermentation in the cream. On the farm it is more difficult thus to control the fermentation. For the average small dairy farmer it is not practicable to use starters and ripen cream, as is done in the creameries. Under the average farm conditions it is best to

control the germs in the cream by exclusion, by retarding the growth by cooling, and by churning before the cream gets old.

Churning temperature.—When the cream is ready to churn, gradually increase the temperature of the cream to the point of churning. This churning temperature varies

in different localities and according to local conditions. The warmer the cream, up to a certain limit, the quicker it will churn. The cooler the cream, the longer the time required for churning. The length of time required for churning should be between 30 minutes and an hour. If the cream is too warm, and it churns too quickly, the butter will "break" in soft masses. When it is in this condition it is impossible to wash out the buttermilk constituents. This is the chief trouble with farm butter. Most farm butter is churned at too high a temperature. Such butter also contains too much water. According to the law, butter cannot contain more than 16 percent of water. The average composition of butter is about as follows:

Fat	-----	84	percent
Water	-----	13	"
Salt	-----	2	"
Curd	-----	1	"
Total	-----	100	"

During the winter months the churning temperature is about 60 degrees. During the summer months the churning temperature is about 55 degrees. The churning temperature depends on the solidity of the butter fat at a given temperature. This hardness and softness of the butter fat varies according to the kind of feed, the stage in the lactation period, the breed, and the individuality of the animal.* These details will not be considered in this connection. The lower the temperature at which the churning can be done, the more complete it will be, or the less butter fat there will be left in the buttermilk.

Coloring the butter.—In order to maintain uniform color of the butter during the different seasons of the year, some artificial color should be added at certain times. When the cows are first put on grass no color should be added before churning. The "June" color is the standard for

* "Principles and Practice of Buttermaking," by McKay and Larsen.

butter. During the winter, when the cows are on dry feed, the most color is needed. The amount of color varies then with the time of the year and with the strength of the color. The dairy farmer should use his own judgment in this respect. It is not desirable that butter should be colored so much that it is almost red. Usually the amount of color varies from a drop to half a teaspoonful to each gallon of cream containing 35 percent of butter fat. The color of the butter must be uniform throughout, and every lot churned should have the same color.

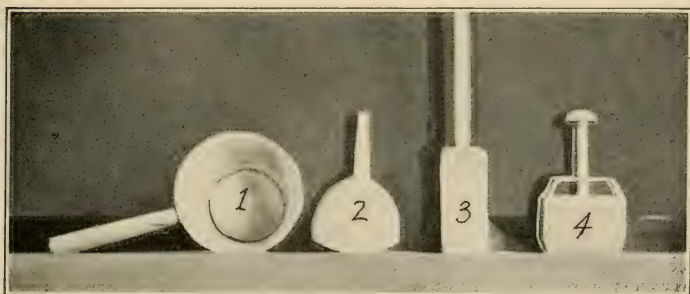


FIG. 105—1. Buttermilk strainer. 2. Butter ladle. 3. Butter tamper. 4. Butter pound printer.

Washing the butter.—During the last part of the churning period the operator should carefully watch the progress of the gathering of the butter. The cream should be churned sufficiently long to obtain a complete churning. If the churn is stopped too soon, too much butter fat will remain in the buttermilk. On the other hand, if the churning is carried too far, the butter granules will gather into lumps, which is also undesirable. Stop the churn when the butter granules are still separate and of the size of corn kernels. At this stage the butter granules cover the whole surface of the buttermilk and are of a clear, bright color.

When this stage is reached, then drain the buttermilk away through the drainhole of the churn. The buttermilk should be strained through a sieve. Allow the butter to

drain for about five minutes. Then rinse the inside of the churn and the butter with a dipperful or two of clean cold water and allow it to drain.

Put the drain plug into the churn and add about three-fourths as much wash water as there was cream in the churn. The wash water should be pure and it should be about the same temperature as is the buttermilk. If only a small amount of wash water is used, the butter particles tend to gather and the buttermilk is not washed away. There should be enough wash water added to float the butter in the churn.

The temperature of the wash water may be varied some to control the degree of firmness in the butter. If the butter is a little soft, the temperature of the wash water may be several degrees lower than that of the buttermilk. On the other hand, if the butter is a little too firm, the temperature of the wash water may be increased a few degrees higher than that of the buttermilk. The range of variation should not be more than about five degrees. Sudden and extreme variations in the temperature of the wash water from that of the butter cause salvy butter.

After the proper amount of wash water has been added, then rotate the churn about a half dozen revolutions. Then drain this water away and add a second portion of clean wash water. Rotate the churn another half dozen revolutions and drain this second set of wash water away.

If the buttermilk is not properly removed, the butter will become mottled and streaky after salting, and it is also likely to become rancid in a short time.

Salting butter.—In order to obtain uniform salting, the moisture should be well drained from the butter. The butter should be salted while still in the churn. The amount of salt to add depends upon the consumer. At any rate there should not be more added than will completely dissolve in the butter. The amount of salt to add will vary from one-fourth of an ounce to one ounce per pound of butter. If the butter has been reasonably well drained be-

fore the salt is added, one-half an ounce per pound of butter is about the right amount to add. The proper amount of salt must be regulated by the person who does the churning and who understands the local conditions. The salt used must be of the best quality of butter salt. Salt that has been allowed to harden will not easily dissolve in the butter. Such salt, too much salt, and lack of proper distribution will cause "gritty" butter. Most consumers object to this condition.

When the proper amount of salt has been weighed out, distribute it over the surface of the butter in the churn. Then put on the cover and slowly rotate the churn. If the butter has been properly handled up to this stage, the flaky butter granules will still be partially separated, so that when the churn is rotated the salt will mix with the butter particles. Slow rotation of the churn will also cause the butter to gather. In that way the salt is first mixed with the butter, and it is properly incorporated with the butter particles.

Working the butter.—The butter should be carefully worked; first, to gather the butter; second, to express the excess of brine; and third, to distribute uniformly the brine and salt in the butter. This latter point is quite important. If there is an excess of undissolved salt in some parts of the butter, it is likely to be mottled. If there is more brine in one part of the butter than in the other, the butter will be streaky. Mottled butter and streaky butter are unsightly and unfit for good markets.

Small dairy farm churns are now made in which butter can be worked. These combined churns are advantageous in several ways. They are handy and save time. The butter is not exposed to room temperature. This is a special advantage during hot weather. These combined churns are also more sanitary. Flies and dust of the room can easily be excluded from the churn. Where the butter has to be taken out in the room on an open butterworker, there is greater danger of getting the butter contaminated.

Where dairy butter is made regularly, the small hand churns are generally used. Such churns do not permit of working the butter within the churn. After the salt has been mixed with the butter it should be removed to a small table butterworker. A hand lever worker serves the purpose. Butter should never be handled directly with the hands. Small ladles are made with which to handle the butter, and can be purchased cheaply.

Packing and marketing butter.—It is important that butter be put in neat, attractive packages. Butter should

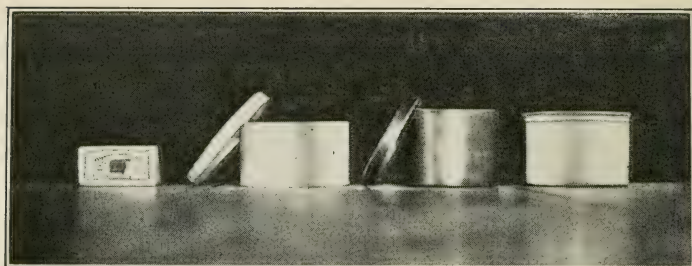


FIG. 106—1. Pound print of butter. 2. Five-pound box made of wood. 3. Five-pound box made of paraffined paper. 4. Five-pound container made of earthenware.

not be rolled up in rags. Such wrapping is not sanitary. The butter is exposed to air and therefore will not keep well, and such butter does not appeal to the best class of butter consumers. The glazed earthen jar furnishes the best receptacle for small lots of farm butter. This jar is easy to clean and the butter keeps well in it. The chief objections that could be raised to it are that it is heavy and breaks easily.

There are now on the market small paraffined paper boxes that are very desirable for holding butter. These paper boxes are single containers. When a five-pound box of butter is sold, the box is not returned, while the glazed earthen jars are returnable.

When butter is made in large quantities on the farm, and it is to be transported by rail, a small wooden tub is probably best for packing. Wooden tubs should not be used unless they are well cleaned and then soaked over night in strong brine. Such tubs should also be lined with parchment paper before butter is packed in them. Unless butter is made on a large scale, wooden tubs should not be used. The glazed earthen jars, or the single container paraffined paper boxes are made in different sizes to suit the needs of the consumer and the convenience of the dairy farmer.

The butter should be firmly tamped into the jar. Fill the jars a little more than full, and with a wet, clean cord cut the top of the butter off even with the edge of the jar. When this excess of butter has been removed, the surface is smooth and level. Then cover the surface with a circular, which is a piece of parchment paper that exactly fits the top of the jar. On the top of the circular scatter a little salt. Then sprinkle this with water, and with the flat palm of the hand spread the brine evenly on the surface. In addition, a piece of paper is put on top of the jar and tied with a cord, and the edges are neatly trimmed off with a pair of scissors. The jar of butter is now ready for the market.

Difficult churning.—There are a number of factors which affect the churning qualities of the cream. Most difficult churnings are due to one or more of these.

First, if the temperature of the cream is too low, the fat globules are so firm that they do not adhere to form butter on being agitated. As has been previously mentioned, the cream should be properly tempered. Too cold and too rich cream will incorporate air and hold it. This causes the cream to foam and adhere to the side of the churn without agitating.

Second, if the cream is very thin, it churns with difficulty. Cream for buttermaking should contain at least 20 percent of butter fat.

Third, the fullness of the churn affects the amount of agitation of the cream by churning. If there is too much

cream in the churn, there is no room for the cream to agitate. If there is just a small amount of cream in the churn, then most of it will adhere to the sides of the churn. The churn should be from one-half to three-fourths full of cream.

Fourth, a too slow or too fast speed of the churn may cause trouble. The former allows the cream to flow around the sides of the churn without agitating. The latter generates centrifugal force so that the cream does not agitate at all.

Fifth, the acidity, or degree of sourness of the cream, is an important factor. Sweet cream is more viscous than is sour cream, and therefore does not churn so easily. However, if the temperature and richness of the cream are right, no difficult churning will result from sweet cream.

Sixth, the fat globules in the milk from different breeds are not of the same size. The fat globules in Jersey and Guernsey milk are large, while the fat globules in the Holstein milk are small. When other conditions are alike, the latter cream churns with more difficulty. The size of the fat globules is also affected by the period of lactation. In the early part of the milking period the fat globules are larger than in the latter part of the lactation period.

There are times of the year when practically all of the cows in a herd are almost dry. At such a time difficult churning is likely to occur.

Seventh, certain feeds, such as grass, silage, and other succulent feeds, tend to produce a softer butter, while dry feeds, exclusively, tend to produce butter fat of greater firmness. This is one reason why the churning temperature is usually higher in the winter than it is during the summer. Cottonseed meal is known definitely to produce harder butter.

Eighth, occasionally difficult churning is due to certain abnormal germs that gain access to the cream. When this is the cause, then the cream assumes a soapy consistency.

This is the worst form of difficult churning to overcome. Scrupulous cleanliness, and disinfection of the stable, the utensils, and all surroundings are the only practical remedies.

Cream to Be Made Into Butter at Factory

To make the butter on the farm involves considerable labor. Under average farm conditions it is also difficult to obtain a uniform high quality of butter. If there are very many dairy farmers in one community making farm butter, there will not be a local market for it. These different small lots of farm butters cannot be shipped and sold advantageously. To overcome these difficulties the different dairy farmers take their milk or cream to a central place to be churned into butter.

The skimming and handling of the cream discussed under the heading "Making Butter on the Farm" applies also to cream to be sent to the factory.

Cold, fresh, sweet and pure cream are important qualities, no matter where the cream is made into butter.

Local creamery.—The local creamery may be privately owned or it may be owned by the dairy farmers co-operatively. It furnishes an excellent market for cream. A local creamery, to be real successful, should make not less than about 100,000 pounds of butter per year. In communities where farmers will work together, a co-operative creamery is the most ideal form. It places the churn close to the cow. The farmers do business with themselves. They receive all the money there is in the cream, minus the cost of manufacture, and there is no danger of loss through financial irresponsibility.

The good and well-managed co-operative creameries have demonstrated that they can pay a very high average price for butter fat.

Through the local creamery organization the farmers may co-operate in many other ways, such as cow testing

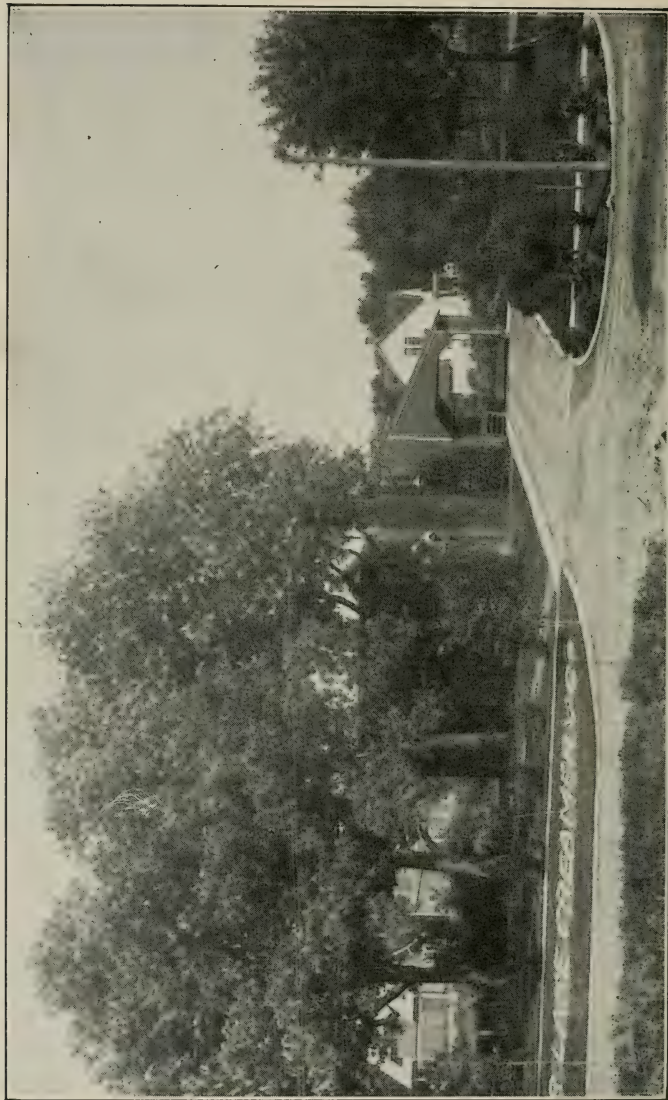


FIG. 107.—Clear Lake, Ia., co-operative creamery. (Courtesy of Prof. M. Mortenson.)

associations, bull associations, purchase and exchange of feeds, salt, coal, stock and other commodities.

A prosperous farmers' co-operative creamery is an asset to any community.

Cream buying station.—The cream buying station has become very common in the central West. This method of

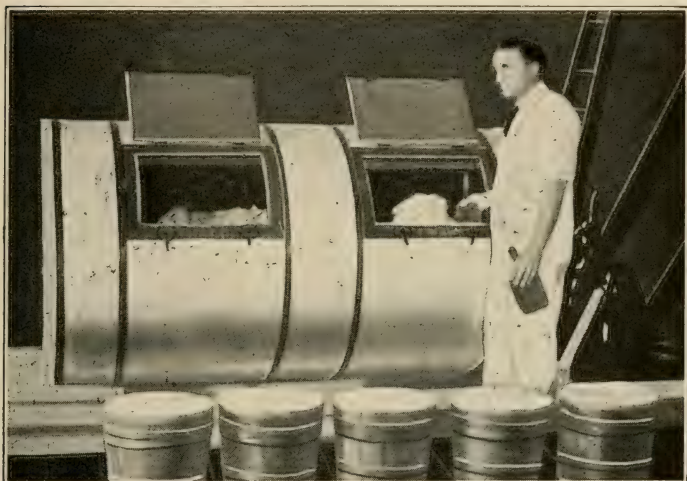


FIG. 108—The finished article. The most concentrated and valuable food known.

handling cream is not the most economic. If one agent handled all of the cream in a community, the cost of handling the cream and of setting a price on it could be reduced. Instead, the cream business usually is split up among several buyers.

Including the commission, drayage, rental, acid, other supplies and equipment, it costs about 3 to 4 cents per pound of butter fat to thus buy and concentrate the cream.

Besides, the cream is often held at the cream station. When purchased, the cream may be several days old. The cream buyer is not often equipped with cooling facilities.

Every hour such cream is kept causes it to deteriorate. From some of the places, cream can be shipped only once each day.

These cream buyers test the cream as soon as delivered and pay cash for the butter fat. This is an inducement to sell for a little less price per pound of butter fat.

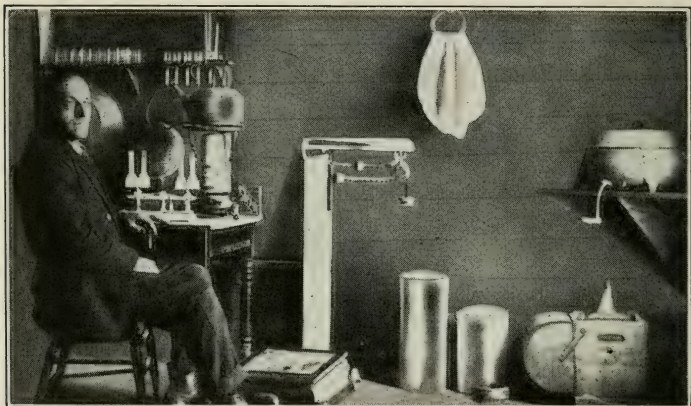


FIG. 109—A cream buying station.

In some localities farmers have their own co-operative cream buying station. The cream from all of the farmers is then sold to the creamery that bids the highest price.

Direct shipment of cream.—By this system, the business between the central creamery and the dairy farmer is carried on by mail. The creamery usually sends out quotations on butter fat, net at the factory. The dairy farmer can then decide for himself whether he will ship the cream direct to the factory, or whether he will sell it to the local cream buyer. If the cream is shipped, the central creamery weighs and tests the cream, and then returns the empty can, and the check is sent by mail.

Some dairy farmers would rather see the cream weighed and tested. This is undoubtedly the chief reason why the direct shipping has not taken the place of the cream buying

station. Theoretically, the direct shipper should be able to obtain more for the cream than does the one who sells to the buying station.

Making Cheese on the Farm

For cheese making it is extremely important that the milk be produced under the most sanitary conditions, and that it be cooled as low as possible without freezing at once

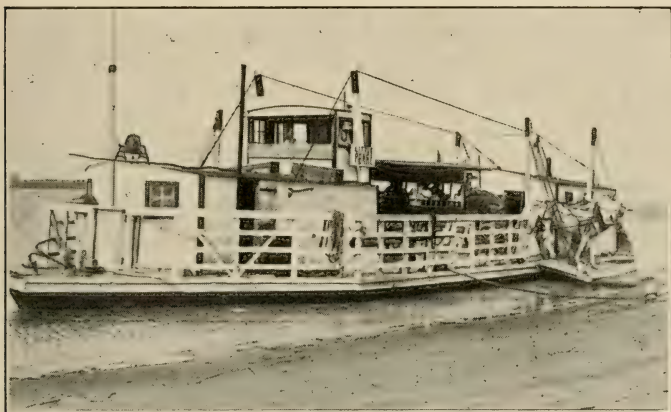


FIG. 110—A ferryboat carrying much cream from one side of Missouri river.

after it is milked. These methods have been described in a previous chapter.

It is also important that the milk be made into cheese at least once each day. It is best if the cheese can be made at once after milking.

Coagulate milk with rennet.—A regular cheese vat, having a water jacket for heating and cooling the milk, is the best container of the milk. Such a vat is not always obtainable on the farm. A clean, sanitary tub, or even a wash boiler, may be used. The milk should all be strained through two thicknesses of cheesecloth as it is poured into the cheese tub.

Then bring the whole amount of milk to a temperature of 85 degrees. If the milk is heated on a stove, great care



FIG. 111—A large central creamery.

should be taken not to heat too rapidly, nor to too high a temperature. A good way is to warm just a small amount and then mix it with the whole. No part of the milk should be heated to a higher temperature than 120 degrees. A higher temperature than this will interfere with the proper curdling of the milk. If the milk from a whole day is made into cheese, it is sufficiently ripe to "set" as soon as the proper temperature has been obtained. On the other hand, if the milk is made

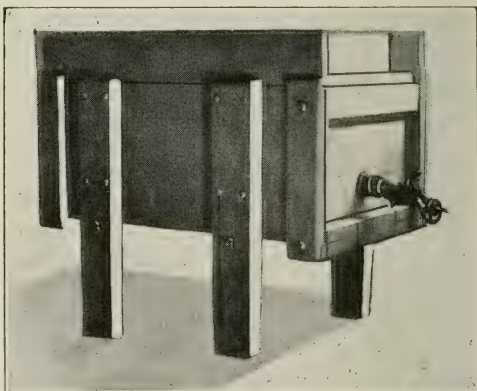


FIG. 112—A vat in which the milk for cheese can be tempered to the proper degree.

into cheese shortly after milking, the milk should stand not less than an hour at 86 degrees F. to ripen before the rennet is added. In case this cannot be done, a small amount of good sour milk, buttermilk, or whey, may be mixed with the milk from which the cheese is to be made. Do not add more

than two percent, or more than two pounds, of the good sour milk to each 100 pounds of cheese milk.

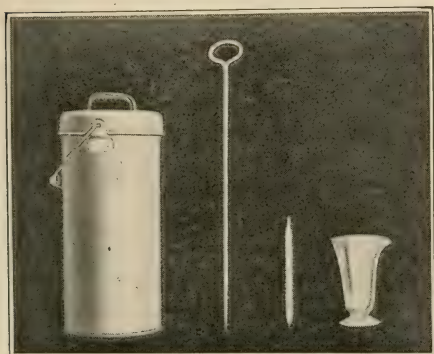


FIG. 113—1. Shot-gun can. 2. Milk and cream stirrer. 3. Dairy thermometer. 4. Graduate for measuring rennet and color.

The next step is to add the color. Butter color will not do. It must be cheese color. The amount to add varies with the strength of the color and with the demands of the market.

The cheese should not be red, nor should it be white. A medium yellow color is liked by most cheese consumers. Add from one-half to one teaspoonful (1-16 to $\frac{1}{8}$ ounce) to each 100 pounds of milk, and mix thoroughly.

The amount of rennet to add also varies with many conditions, the chief of which are the acidity of the milk, the strength of the rennet, and the temperature of the milk. The amount of rennet added should be such that the milk curdles in from 20 to 30 minutes. This amount will be about one ounce to 250 pounds of milk.

When the rennet has been measured out, it should be mixed with about 40 times the amount of cold water. When ready to add the diluted rennet, stir the milk. This is done so that the rennet will be completely mixed before it has a chance to act on any one part of the milk. Continue to stir

the milk for about two minutes. Do not disturb the milk while it is coagulating.

Cutting the curd.—The curd should not be cut till it is reasonably solid. To test when it is ready, insert the fore finger into the curdled milk at an angle of 45 degrees, then slowly lift the finger straight up. If the curd splits smoothly over the finger, it is ready to cut; while if it breaks into small pieces and is ragged, it is too soft to cut.

Usually the time required for the curd to set, from the time the rennet is added, is from three-fourths to one hour. About 20 minutes is required for the milk to curdle. Fully as much time will be required for the curd to set before it is ready to cut.

Special cheese knives are made for cutting the curd into small squares. For making cheese on a small scale on the farm these are not necessary. A homemade, long-bladed wooden knife may be used. The curd should be cut lengthwise and crosswise into small cubes. A wire toaster is a convenient tool for completing the cutting of the curd into cubes not over half an inch in diameter. The particles should be as uniform in size as is possible in order to obtain an even "cook," or heating.

Heating the curd.—The curd is gradually heated to expel the moisture and to make the curd firm. At this stage there will be considerable whey. Dip some out and heat it to a temperature of 135 degrees. Then gradually pour it back and mix it very gently with the contents of the vat. Do not allow the curd to mat. Keep the particles separate by gentle stirring. If roughly handled, while the curd particles are soft, much of the fat will be lost in the whey.

Pour in only enough hot whey to raise the temperature of the whole three or four degrees, then gently stir for five minutes. Add hot whey again to increase the temperature three or four degrees more, and stir five minutes. Continue this until the temperature has reached about 100 degrees. It will thus require about 30 to 40 minutes to bring the temperature from 86 to 100 degrees. Allow the curd to

remain at this temperature till it is "cooked" through. When this is done, the curd is so hard that when a handful of it is squeezed, and when the grip again is released, the curd particles will not stick together.

After the curd has reached this stage, allow it to remain in the whey for 30 to 45 minutes more. This is done to develop acid in the curd. In the manufacture of cheddar cheese in the factory, the whey is drawn and the curd is piled to develop the proper amount of acid. On the farm this method is hardly practicable. There is a slight danger of overcooking the curd by the modified method.

The curd thus left in the whey should be closely watched so that it does not get too much acid. A curd that has developed too much acid produces a dry cheese, lacking in flavor. A cheese that contains too little acid is likely to develop gas when put into the curing room. The curd may be tested occasionally on a piece of hot iron. When it strings about half an inch, then draw the whey from the curd.

While the curd is developing acid in the whey, it must not be allowed to mat. Stir it just enough to keep it from matting.

When the proper amount of acid has been developed, then drain off the whey. The curd should be gently stirred to aid in getting the whey effectively drained away from it.

Preparing the cheese for the press.—When the curd is ripened as mentioned above, "the milling process," or subdividing the curd is done away with. The curd is ready for the salting as soon as it has been well stirred and the whey is thoroughly drained off.

About one pound of salt should be added to the curd for each 300 pounds of milk used. The amount of salt the maker should regulate according to the quality of cheese he wishes to make. Too much salt makes the cheese too dry and retards the curing. Too little salt causes the cheese to ripen too fast. The salt should be thoroughly mixed with the curd to secure uniform distribution.

If cheese is regularly made on the farm, special hoops should be purchased. The Young America hoop is probably of most suitable size for farm cheeses. These hoops make a cheese that is 7 inches in diameter. The height is variable. The most suitable weight to make a Young America cheese is about 10 pounds. If a cheese is made only now and then, a hoop may be made from a small tin pail hav-

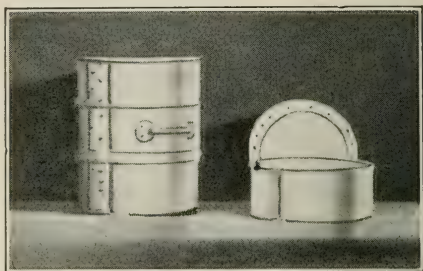


FIG. 114—A cheese hoop for making "Young America" cheese.

ing straight sides and a diameter of about 7 to 8 inches. There is no objection to a hoop of greater diameter. If such a hoop is used, holes should be made in the end to permit draining of the whey during pressing.

The hoops should first be thoroughly cleaned. Then place some cheesecloth within the hoop. Make the folds as smooth as possible. The curd is then placed in the hoop. Special hoop liners, or bandages, and circles should be purchased if the hoops of regular sizes are used.

Care should be taken to keep the curd warm. Do not expose it too much to the cold air. Cold curd will not unite when put into the press.

When the curd has been placed in the hoop, then put the follower (circular board) on and place it in the press.

Pressing the cheese.—If much cheese is made on the farm, one of the regular cheese presses should be purchased. If only a small amount is made, a homemade press will serve the purpose. A press such as is illustrated will do the work. An old wagon tongue will serve the purpose of the lever. One end may be fastened to the side of a

building with a strong set of hinges, or it may be inserted under a block of wood fastened to the wall.

In pressing the cheese in such a press, care should be taken to keep the lever level, otherwise the cheese will not be regular in shape.

When the cheese is first put into the press, very little pressure should be applied. The weight should be close to the cheese. The pressure is gradually increased by moving the weight toward the end of the lever. In case the curd should be a little cold, greater pressure should be applied when the curd is first put into the press. A final pressure of about 500 to 800 pounds should be applied to the cheese. This does not mean that the weight should be that heavy.

When the cheese has been in press for one hour, it should be turned, and the bandage or lining should be adjusted. If the cheese does not unite well, apply a little warm water. In another two hours turn the cheese again. The cheese should be in press not less than 24 hours. In case the cheese does not unite well in pressing, it may be soaked in warm water while still in the bandages, then put back in the press.

The composition of American Cheddar cheese is as follows:

Water	-----	34.4	percent
Casein	-----	26.4	"
Fat	-----	32.7	"
Sugar	-----	2.9	"
Ash	-----	3.6	"
Total		100	"

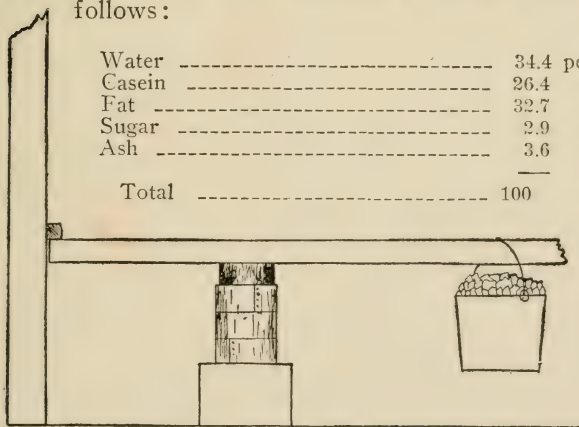


FIG. 115—Illustration of a simple homemade cheese press.

Curing the cheese.—So far, the cheese is only half made. The curing is a very important part of cheese making. The temperature and humidity of the curing room should both be under reasonable control. The curing room must not be



FIG. 113—A successful farmers' co-operative cheese factory.

too dry. This will cause the cheese to dry too quickly, and to crack. There should not be a draft in the curing room, yet there should be ventilation.

If the curing room is too dry, the floor of the room may be sprinkled with water or a wet sheet may be hung up in the room.

If it is desired to have the cheese cure quickly, then the temperature may be kept at about 70 degrees. The best cheese, however, is obtained from slow curing in a cold room. A temperature between 50 and 60 degrees produces good results.

A cellar is probably the best available place for a curing room on the farm.

When the cheeses are first put in the curing room on the farm, they should be turned daily; and during the ripening process, should they become moldy on the surface, the cheese and shelving should be washed thoroughly with a strong salt brine.

Making Soft Cheeses on the Farm

Numerous kinds of soft cheeses can be made successfully on the farm, such as cottage, neufchatel, pimento, cream and club. These are much easier to make under farm conditions than the cheddar type above described.

Cottage cheese.—Either skim milk or buttermilk may be used for making cottage cheese. Skim milk is used most.

The sweet skim milk is brought to a temperature of between 70 to 75 degrees. About an ounce (two tablespoons) of good, clean starter (sour milk or buttermilk) is added for every gallon of milk, and then stirred well. Then add rennet at the rate of one ounce of rennet to each thousand pounds of milk. The rennet should previously be diluted with cold water (half an ounce of rennet to a pint of water).

Set the milk away to curdle, cover it with a clean cloth to prevent dust from entering and also to aid in maintaining the desired temperature, 70 to 75 degrees. About 12 to 24 hours will be required to complete the curdling properly.

When the curd has become reasonably firm, it may be broken up by means of gentle stirring. Should the curd be too soft to separate from the whey, the temperature may be raised to about 85 to 95 degrees. Do not warm too much. This will make the curd hard and granular. The cheese should remain soft to be most palatable.

Then remove the cheese to a double cheesecloth, and hang it up to drain. Six to eight hours' time will be required for this.

When the loose whey has drained away, add and mix salt at the rate of from one to 1½ ounces to five pounds of curd.

Some also add caraway seed to give flavor. Some like rich cottage cheese. In that case cream is mixed with it. This results in a smoother, richer, and more palatable cottage cheese, but more expensive.

From 15 to 20 pounds of cottage cheese is obtained from 100 pounds of milk.

Buttermilk is also used for cottage cheese. In order to separate the curd from buttermilk, it is necessary to heat it to a temperature of about 120 degrees for about two hours. This is necessary on account of the softness and fineness of the buttermilk curd. Otherwise, the process of manufacture is the same as when sour milk is used.

This cheese may be marketed in one-pound paper containers made for this purpose, or it may be packed into glazed earthen jars. During the summer restaurants sell and serve considerable cottage cheese. Cottage cheese is used for sandwiches, it is eaten directly with cream, salt and pepper, and it is used for salads.

Cottage cheese may also be made in the same manner from naturally soured milk without any rennet. In that case, it is necessary to warm the milk to about 90 degrees to separate the whey from the curd.

Neufchatel cheese.—Fresh, clean, and sweet whole milk is tempered to 70 to 72 degrees. To every gallon of milk add one-fourth to one-half ounce (one to two tablespoonfuls) of clean, sour buttermilk, or clabbered milk, and stir thoroughly. Then add four or five drops of rennet (diluted in about one ounce of cold water) to every gallon of milk, and stir thoroughly. If rennet tablets (junket tablets) are used, figure each tablet being equal in strength to 20 drops of rennet. The water in which the vessel of milk is set should be from 70 to 72 degrees. Cover the milk with a cloth and allow it to stand until the curd has coagulated firmly. This will require from 14 to 18 hours. Then carefully transfer the curd to a cotton cloth, using a small dipper. As far as possible, avoid breaking up the curd. A convenient method for holding the strainer cloth is to fasten

the cheesecloth across the top of a wash boiler or tub, using clothes pins to hold the cloth strainer firmly at the edge.

Occasionally scrape down the curd to the center of the cloth with a case knife. This prevents the drying of the curd around the sides. When the curd begins to become firm, and most of the whey is drained, the cloth is folded together in a tight ball and the draining is continued.

At intervals unfold the cloth and scrape the dry curd from the surface. Salt to suit the taste, or at the rate of two to 2¼ ounces to 10 pounds of curd, and the cheese is ready to use.

From 100 pounds of milk 18 to 20 pounds of Neufchatel cheese can be made.

Neufchatel curd may serve as the foundation for several other kinds of soft cheeses.

Pimento cheese.—The curd is handled as described above in making Neufchatel cheese. The only difference is that the latter is not colored; while for the pimento cheese, cheese color should be added to the milk at the rate of one-sixteenth ounce, or about one-half teaspoonful to each 10 gallons of milk. This will be equal to from six to eight drops for each gallon of milk.

The pimentos (red peppers) are ground fine in a meat grinder, and worked into the curd at the rate of one ounce of pimento to each pound of curd. A small amount of cayenne pepper is also added at the same time.

Cream cheese.—Cream cheese may be made from cream containing from 10 to 12 percent of butter fat in much the same way as the Neufchatel curd, by adding and mixing well-ripened or sour cream. Add enough of the sour cream to the curd to give it the desired creamy consistency. Add salt at the rate of one ounce to five pounds of curd, or to suit the taste.

Club cheese.—First remove the rind from well-made and well-cured cheddar, or ordinary hard cheese. Slice this cheese and run it through a meat grinder. To each pound of ground cheddar cheese, add about two ounces of fresh

butter. Mix the cheese and butter thoroughly, and then run the mixture through the meat grinder to secure a homogeneous mixture.

The cheese is ready for use immediately. It should be packed in small, air-tight jars or glasses. Club cheese is very nutritious and palatable.

Manner of Disposal Affects Income

One hundred pounds of four percent milk equals about 47 quarts. Each quart, when delivered, brings a gross income of about 8 cents per quart. The 47 quarts, or 100 pounds, therefore, would amount to \$3.76 when sold for direct use. The expense of delivering and bottling must be considered in this connection. The cost of distribution from the farm about equals the cost of production.

If the 100 pounds of four percent milk were made into butter, the following income may be expected:

4.7 pounds of butter @ \$0.35-----	\$1.56
(4 pounds of butter fat plus 1-6 overrun equals 4.7 pounds of butter)	
86 pounds of skim milk @ \$0.30 per cwt. -----	.26
9 pounds of buttermilk @ \$0.30 per cwt. -----	.03
Total income -----	\$1.85

If the 100 pounds of four percent milk were made into cheese, the products would bring about the following income:

10 pounds of cheese @ \$0.25-----	\$2.50
90 pounds of whey @ \$0.20 per cwt. -----	.18
Total income -----	\$2.68

Soft cheeses of the various kinds, such as cream, cottage, or brick cheese, may be successfully made on the farm. A larger yield may be contained than from cheddar, but the soft cheese does not keep so well. It demands an immediate and steady market.

The foregoing illustrations have been cited to show that the manner of marketing milk has an important bearing upon the amount of income.

The making of ice cream and various other kinds of cheese and by-products will not be discussed in this connection. For the making of ice cream and for other uses of milk and cream, the reader is referred to "Dairy Technology," by Larsen and White.

APPENDIX

Armsby's requirements for milk production in addition to maintenance:

	Lbs. True Protein	Therms Net Energy
For 1 pound of milk testing 2.5 percent.....	.041	.19
For 1 pound of milk testing 3.0 percent.....	.043	.21
For 1 pound of milk testing 3.5 percent.....	.045	.24
For 1 pound of milk testing 4.0 percent.....	.049	.27
For 1 pound of milk testing 4.5 percent.....	.052	.29
For 1 pound of milk testing 5.0 percent.....	.055	.32
For 1 pound of milk testing 5.5 percent.....	.058	.34
For 1 pound of milk testing 6.0 percent.....	.061	.36
For 1 pound of milk testing 6.5 percent.....	.064	.39
For 1 pound of milk testing 7.0 percent.....	.068	.41

Armsby's standard for maintenance requirements for cows:

Live Weight in Pounds	Digestible Protein in Pounds	Therms Net Energy
750	.413	4.95
850	.449	5.38
950	.483	5.80
1050	.517	6.20
1150	.548	6.58
1250	.580	6.96
1350	.611	7.33
1450	.641	7.69
1550	.670	8.03
1650	.698	8.38

The Armsby table of dry matter, digestible protein, and net energy values in 100 lbs. of various feeding stuffs:

Feeding stuffs	Total dry matter	Digestible protein	Therms Net energy value
Green fodder and silage:	Pounds	Pounds	Pounds
Alfalfa.....	28.2	2.50	12.45
Clover, crimson.....	19.1	2.19	11.30
Clover, red.....	29.2	2.21	16.17
Corn fodder, green.....	20.7	.41	12.44
Corn, silage.....	25.6	1.21	16.56
Hungarian grass.....	28.9	1.33	14.76
Rape.....	14.3	2.16	11.43
Rye fodder.....	23.4	1.44	11.63
Timothy.....	38.4	1.04	19.08
Hay and dry coarse fodder:			
Alfalfa hay.....	91.6	6.93	34.41
Clover hay, red.....	84.7	5.41	34.74
Soy bean hay.....	88.7	7.68	38.65
Cowpea hay.....	89.3	8.57	42.76
Corn forage, field-cured.....	57.8	2.13	30.53
Corn stover.....	59.5	1.80	26.53
Hungarian hay.....	92.3	3.00	44.03
Oat hay.....	84.0	2.59	36.97
Timothy hay.....	86.8	2.05	33.56
Straws:			
Oat straw.....	90.8	1.09	21.21
Rye straw.....	90.4	.63	20.87
Wheat straw.....	90.4	.37	16.56
Roots and tubers:			
Carrots.....	11.4	.37	7.82
Mangels.....	9.1	.14	4.62
Potatoes.....	21.1	.45	18.05
Rutabagas.....	11.4	.88	8.00
Turnips.....	9.4	.22	5.74
Grains:			
Barley.....	89.1	8.37	80.75
Corn.....	89.1	6.79	88.84
Corn-and-cob meal.....	84.9	4.53	72.05
Oats.....	89.0	8.36	66.27
Pea meal.....	89.5	16.77	71.75
Rye.....	88.4	8.12	81.72
Wheat.....	89.5	8.90	82.63
By-products:			
Brewers' grains—dried.....	92.0	19.04	60.01
Brewers' grains—wet.....	24.3	3.81	14.82
Buckwheat middlings.....	88.2	22.34	75.92
Cottonseed meal.....	91.8	35.15	84.20
Distillers' grains—dried			
Principally corn.....	93.0	21.93	79.23
Principally rye.....	93.2	10.38	60.93
Gluten feed.....	91.9	19.95	79.32
Gluten meal—Buffalo.....	91.8	21.56	88.80
Gluten meal—Chicago.....	90.5	33.09	78.49
Linseed meal, old process.....	90.8	27.54	78.92
Linseed meal, new process.....	90.1	29.26	74.67
Malt sprouts.....	89.8	12.36	46.33
Rye bran.....	88.2	11.35	56.65
Sugar beet pulp, fresh.....	10.1	.63	7.77
Sugar beet pulp, dried.....	93.6	6.80	60.10
Wheat bran.....	88.1	10.21	48.23
Wheat middlines.....	84.0	12.79	77.65

Haecker's feeding standard of requirements for milk production:

	Crude Protein	Carbohydrates	Ether Extract
For each pound of 3.0% milk.....	.042	.189	.0133
For each pound of 3.5% milk.....	.045	.211	.0149
For each pound of 4.0% milk.....	.048	.233	.0164
For each pound of 4.5% milk.....	.051	.253	.0179
For each pound of 5.0% milk.....	.054	.271	.0191
For each pound of 5.5% milk.....	.057	.289	.0204
For each pound of 6.0% milk.....	.060	.307	.0216
For each pound of 6.5% milk.....	.063	.325	.0229
For each pound of 7.0% milk.....	.066	.341	.0242

Haecker's standard of food for maintenance:

Weight Pounds	Protein Pounds	Carbohydrates Pounds	Fat Pounds
750.....	.525	5.25	.08
850.....	.595	5.95	.08
950.....	.665	6.65	.09
1050.....	.735	7.35	.10
1150.....	.805	8.05	.11
1250.....	.875	8.75	.12
1350.....	.945	9.45	.13
1450.....	1.015	10.15	.14
1550.....	1.085	10.85	.15
1650.....	1.154	11.54	.16

Haecker's table of nutrients in a pound of feeding stuffs:

	Protein	Carbohydrates	Fat
Concentrates:			
Corn.....	.079	.667	.043
Barley.....	.087	.656	.016
Oats.....	.092	.473	.042
Wheat.....	.102	.692	.017
Rye.....	.099	.676	.011
Millet.....	.089	.450	.032
Kaffir corn.....	.078	.571	.029
Sorghum.....	.070	.521	.031
Shorts.....	.122	.500	.038
Bran.....	.129	.401	.034
Peas.....	.168	.518	.007
Corn oil meal.....	.202	.445	.088
Gluten feed.....	.204	.507	.027
Oil meal.....	.293	.327	.070
Gluten meal.....	.258	.422	.025
Cotton, S. M.....	.372	.169	.122
Roughage, cured:			
Fodder corn.....	.025	.346	.012
Stover.....	.017	.324	.007
Sorghum.....	.024	.321	.016
Timothy.....	.028	.434	.014
Prairie hay.....	.029	.415	.012
Red top.....	.048	.469	.010
Oat hay.....	.043	.464	.015
Millet.....	.032	.485	.010
Marsh hay.....	.024	.299	.009
Soy bean.....	.109	.401	.015
Cow pea.....	.107	.382	.012
Clover.....	.068	.358	.107
Alsike.....	.084	.425	.015
Alfalfa.....	.110	.396	.012
Roughage, green:			
Fodder corn.....	.010	.116	.004
Sorghum.....	.006	.122	.004
Oats.....	.026	.189	.010
Timothy.....	.012	.191	.006
Red top.....	.021	.212	.006
Clover.....	.029	.148	.007
Alsike.....	.027	.131	.006
Alfalfa.....	.039	.127	.005
Cow pea.....	.018	.087	.002
Soy bean.....	.032	.110	.005
Barley.....	.019	.102	.004
Silage:			
Corn.....	.009	.113	.007
Sorghum.....	.006	.149	.002
Cow pea.....	.015	.086	.009
Clover.....	.020	.135	.010
Soy bean.....	.027	.087	.013
Alfalfa.....	.030	.085	.019
Miscellaneous:			
Potato.....	.009	.163	.001
Sugar beet.....	.011	.102	.001
Mangel.....	.011	.054	.001
Turnip.....	.010	.072	.002
Rutabaga.....	.010	.081	.002
Cabbage.....	.018	.082	.004
Pumpkin.....	.010	.058	.003
Rape.....	.015	.081	.002
Beet pulp.....	.006	.073	.000
Straw			
Wheat.....	.004	.363	.004
Oats.....	.012	.386	.008
Barley.....	.007	.412	.006

* ORGANIC AND MINERAL ANALYSES OF FOODS—

Description	Moisture	Protein (N x 6.25)	Nitrogen free extract	Ether Extract	Crude Fiber
Wheat.....	12.31	10.31	69.59	1.54	2.82
Wheat flour.....	13.92	9.74	74.67	1.25	.25
White bread.....	34.62	9.22	53.58	1.19	.28
Wheat bran.....	10.02	15.75	55.30	4.26	8.62
Wheat middlings.....	11.02	18.84	54.94	5.11	5.97
Wheat germ.....	8.50	29.44	44.37	10.07	2.91
Wheat gluten.....	8.42	80.88	9.15	.65	.19
Red dog flour.....	10.52	18.50	58.20	5.87	3.19
Corn.....	14.24	8.69	69.11	4.03	2.72
Corn meal, bolted.....	13.52	8.52	72.96	3.27	1.04
Corn bran.....	11.00	5.25	66.26	3.10	13.21
Pearl hominy.....	11.90	6.88	78.77	1.46	.46
Gluten feed.....	7.99	27.50	48.86	3.64	8.83
Distiller's grains, corn.....	7.71	32.06	37.52	8.90	12.43
Distiller's grains, rye.....	8.33	29.25	36.93	6.76	15.34
Brewer's grains.....	6.88	19.69	50.18	5.74	14.76
Malt sprouts.....	7.46	24.75	45.43	2.10	14.46
Oats.....	8.89	10.88	60.09	4.28	12.48
Kaffir corn.....	11.89	10.56	70.91	3.58	1.88
Rice.....	10.15	6.48	82.26	.36	.47
Rice Polish.....	11.13	12.48	54.29	11.77	3.20
Apple.....	85.25	.24	13.52	.10	.63
Prune, dried.....	24.53	2.78	66.67	1.26	1.61
Banana.....	72.63	1.13	24.79	.36	.29
Date, dried.....	15.44	2.26	77.44	.91	2.32
Onion.....	87.29	1.64	9.41	.33	.79
Cabbage.....	93.05	1.16	4.80	.25	.31
Potato, sweet.....	73.34	1.28	23.35	.39	.80
Potato, white.....	82.42	1.97	14.57	.09	.29
Mangel-wurzel.....	88.54	1.68	7.69	.11	.80
Beet pulp, dried.....	9.53	8.25	59.29	.77	19.25
Clover hay.....	7.57	13.00	40.74	3.06	28.87
Soy bean hay.....	10.61	17.09	36.57	2.47	25.59
Cowpea hay.....	10.62	22.25	33.64	3.03	19.70
Alfalfa hay.....	7.42	14.41	40.44	1.87	29.48
Timothy hay.....	8.06	5.34	48.13	2.29	32.98
Millet hay.....	4.89	6.00	47.56	2.89	33.06
Corn stover.....	6.96	5.48	46.88	1.39	32.77
Bluegrass hay.....	8.21	9.10	40.97	2.89	34.01
Wheat straw.....	5.48	1.75	45.13	1.71	42.48
Agar agar, dried.....	15.29	1.88	77.34	.37	.89
Soy beans.....	8.63	39.41	22.54	19.27	5.09
Navy beans.....	14.49	22.23	53.13	1.77	4.60
Cowpeas.....	14.24	22.14	52.94	1.33	5.66
Peanuts, roasted.....	2.71	27.41	17.32	47.95	2.14
Linseed oilmeal.....	10.34	35.51	30.91	6.24	11.20
Cottonseed meal.....	8.58	35.88	30.27	11.14	7.15
Milk, skim.....	90.41	3.21	5.52	.18	.....
Whey.....	93.96	.79	4.69	.01	.....
Mutton.....	61.67	17.18	.....	20.26	.....
Eggs.....	73.22	12.93	.....	10.21	.....
Tankage, digester.....	9.06	58.59	.....	9.29	4.36
"Banner" bone flour.....	.....	.....	.....	.....	.....
Blood, swine.....	78.82	20.69	.....	.27	.....
"Black" albumen.....	10.76	82.13	.....	1.02	.....

NOTE: The high protein contents of soy bean hay and cowpea hay as above reported are due in part to the facts that these samples were a little less advanced in maturity than as usually cut for hay and were dried in the laboratory without loss of parts.

CEREAL PRODUCTS—PARTS PER 100 OF FRESH SUBSTANCE

Ash	Potassium	Sodium	Calcium	Magnesium	Sulphur	Chlorine	Phosphorus
1.54	.520	.051	.050	.130	.198	.084	.373
1.65	.050	.110	.019	.016	.145	.070	.088
1.11	.102	.381	.025	.003	.129	.626	.088
6.06	1.320	.201	.125	.531	.267	.090	1.110
4.12	1.021	.165	.096	.383	.234	.025	.876
4.71	.295	.721	.071	.340	.325	.070	1.050
.71	.007	.028	.078	.045	.920	.050	.200
3.72	.380	.660	.120	.290	.260	.140	.830
1.21	.340	.026	.012	.108	.147	.063	.260
.69	.166	.098	.013	.106	.106	.061	.229
1.18	.365	.000	.027	.078	.110	.046	.139
.53	.135	.000	.004	.032	.160	.046	.098
3.18	.250	.424	.247	.220	.585	.090	.542
1.38	.013	.142	.043	.050	.470	.060	.290
3.39	.041	.071	.130	.179	.374	.026	.420
2.75	.172	.259	.157	.160	.390	.058	.468
5.70	.293	1.350	.147	.180	.800	.360	.690
3.38	.419	.168	.102	.118	.195	.070	.395
1.18	.254	.058	.012	.125	.164	.104	.239
.28	.036	.029	.008	.025	.102	.036	.093
7.13	1.137	.110	.027	.659	.168	.134	1.497
.27	.118	.010	.004	.005	.006	.005	.009
2.15	1.017	.034	.057	.042	.050	.038	.083
.80	.353	.066	.010	.035	.006	.115	.033
1.62	.564	.097	.071	.073	.074	.241	.065
.55	.183	.012	.033	.017	.076	.023	.041
.50	.173	.002	.041	.015	.063	.017	.018
.84	.322	.016	.022	.057	.031	.018	.050
.67	.272	.031	.005	.058	.025	.010	.047
1.18	.444	.082	.015	.041	.026	.158	.030
2.91	.314	.167	.660	.256	.125	.043	.062
6.76	1.701	.062	1.142	.270	.176	.239	.169
7.67	1.586	.130	1.232	.619	.231	.075	.212
10.76	.780	.646	1.814	.980	.315	.149	.253
6.38	.770	.453	1.046	.370	.276	.149	.221
3.20	.564	.317	.177	.102	.149	.183	.113
5.60	1.273	.094	.310	.249	.151	.117	.165
6.52	1.718	.061	.472	.086	.174	.287	.095
4.82	1.290	.129	.308	.220	.307	.215	.222
3.45	.796	.224	.205	.060	.150	.198	.036
4.23	.112	.114	.660	.483	1.770	.034	.020
5.06	1.913	.343	.210	.223	.406	.024	.592
3.78	1.186	.074	.201	.176	.192	.040	.367
3.69	1.403	.162	.100	.208	.240	.040	.456
2.47	.059	.548	.066	.175	.247	.023	.388
5.80	1.098	.253	.362	.488	.408	.085	.705
6.98	1.656	.259	.266	.548	.490	.038	1.352
.69	.122	.047	.128	.014	.034	.091	.094
.56	.167	.028	.044	.008	.008	.118	.039
.92	.239	.082	.002	.024	.233	.090	.182
.93	.055	.104	.067	.016	.204	.166	.229
15.51	.547	1.664	2.948	.145	.608	2.444	1.627
.....	.065	.091	23.990	1.160			14.940
1.00	.220	.290	.007	.006	.137	.250	.059
4.14	.240	1.247	.035	.010	.730	1.380	.109

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